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POPULAR SERIES

PRIMARY LESSONS IN PHYSIOLOGY AND HYGIENE

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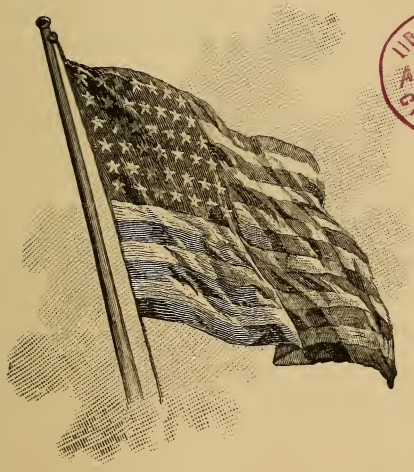
THE POPULAR SERIES

PRIMARY LESSONS

IN

PHYSIOLOGY AND HYGIENE



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TO THE TEACHER.

THIS little manual is intended to give to beginners a general, untechnical knowledge of the human body—its parts, their forms and functions, their coöperation and interdependence—and to inculcate some of the more elementary hygienic truths. The outline thus traced may be filled in by such oral illustration as, in the judgment of the teacher, will best serve to light up the picture and fasten it on the memory.

The text is as compact as the range of topics and an endeavor at simplicity and attractiveness of treatment would permit. The fourteen chapters into which it is divided will be found to provide for the successive lessons and reviews of the usual school term. The daily *vivâ voce* reading of the lesson given out, with any explanations that may be needed, will tend to obviate mere verbal memorizing and rote recitation.

Written exercises upon the topic of each chapter, when the study of it is completed, will afford a close test of actual acquirement. Such exercises might take the form of answers—each of which should be a complete statement—to a brief series of blackboard questions, so framed as to bring out in their order the salient features of the subject. The facts embodied in the resulting series of written answers will, because of the writing of them, be all the better fixed in the mind of the learner.

"Such a course of physiology as is needful for the comprehension of its general truths and their bearings on daily conduct is an all-essential part of a rational education."—HERBERT SPENCER.

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PRIMARY PHYSIOLOGY.

CHAPTER I

INTRODUCTORY.

OUR bodies stand erect, are rounded in all their parts, and graceful and strong in their actions. The man of average size is five feet eight and one half inches in height, measures thirty-six inches around the body, and weighs one hundred and fifty pounds.

The parts of the body as we see them are:

1. the head and neck,
2. the trunk, and
3. the extremities.

The head is formed of the face and the skull. The neck supports the head.

The trunk has two parts:

1. the upper portion, called the *chest*, or *thorax*, which contains the heart and lungs, and
2. the lower part, called the *abdomen*, which holds the liver, stomach, and intestines.

The extremities are of two kinds:

1. *the upper extremities*, which form the arms and hands, and
2. *the lower extremities*, which form the legs and feet, for supporting us when we stand or walk.

A closer examination of the body shows us that it is formed of many parts, called *organs*, each of which has some special use. The principal organs are used as follows:

The bones for support.

The muscles for motion.

The heart for circulating the blood.

The lungs for breathing.

The stomach and intestines for digestion.

The brain and nerves for feeling, and for controlling all the parts.

Men have often taken bodies like our own to pieces, and have separated the parts from one another. In this way, and by the study of the living bodies of men and of animals, they have learned how the body is formed and how its parts are used.

Summary for Review.

1. *What is the height of the average man?*
   Five feet eight and one half inches.
2. *How heavy is the average man?*
   He weighs one hundred and fifty pounds.
3. *What are the main parts of the body?*
   The head and neck, the trunk, and the extremities.
4. *How is the head divided?*
   Into face and skull.
5. *How is the trunk divided?*
   Into chest and abdomen.
6. *How are the extremities named?*
   The upper and the lower.

7. *What is an organ?*
   A part of an animal or vegetable body that has a special use.
8. *What are some of the chief organs of the human body?*
   Bones, muscles, heart, lungs, stomach and intestines, brain and nerves.
9. *For what are the bones?*
   They support the other parts.
10. *For what are the muscles?*
    They move the whole body.
11. *For what is the heart?*
    To circulate the blood.
12. *For what are the lungs?*
    To breathe the air and purify the blood.
13. *For what are the stomach and intestines?*
    To digest the food.
14. *For what are the brain and nerves?*
    To feel, and to control all parts.

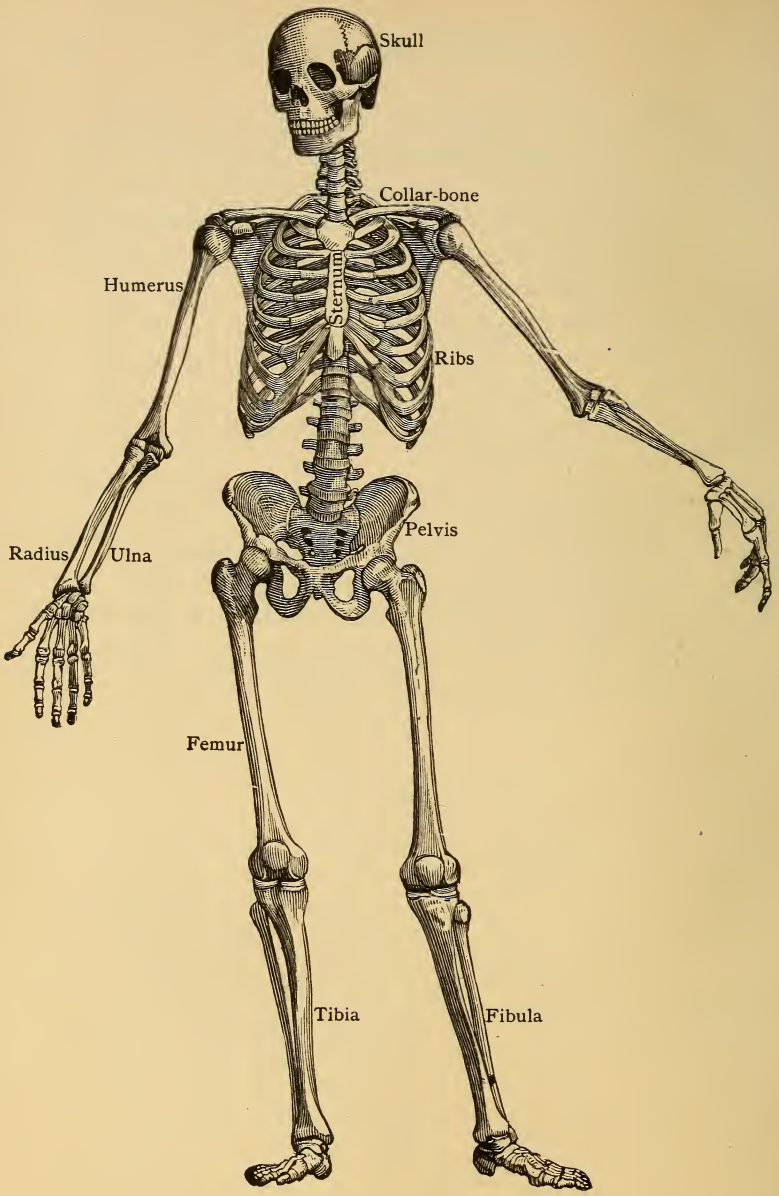

Fig. 1.

THE SKELETON.

CHAPTER II.

THE BONES.

Definitions.

căr′ti lage, an elastic tissue which protects the joints of the bones.

lĭg′a ment, a strong band, joining one bone to another.

pĕl′vis, the basin-shaped bones of the hips.

pĕr i ŏs′te um, the membrane that coats and nourishes the bones.

spī′nal, pertaining to the spine or backbone.

sū′tūres, the jointings of the skull bones.

syn ō′vi al, slippery, lubricating.

vĕr′te bræ, the small, movable bones which, together, form the backbone.

OUR bodies have a strong frame-work of bones called the **skeleton.** (See Fig. 1.) Without this skeleton we could not stand; we could neither lift a hand nor take a step.

The bones of the skeleton—

1. give general shape to the body;
2. bear our weight;
3. aid in motion; and
4. protect the delicate organs.

There are two hundred and six of these firm, hard bones, of various shapes and sizes, all nicely fitted together for their different uses. They may be divided into three groups:

1. the bones of the head;
2. the bones of the trunk;
3. the bones of the extremities.

The bones of the **head** form the *skull* and *face*. The eight bones of the *skull* are broad and curved, and are fitted together at their edges in firm seams or sutures, and formed into a strong, hollow place for holding and protecting the brain. (See Fig. 2.)

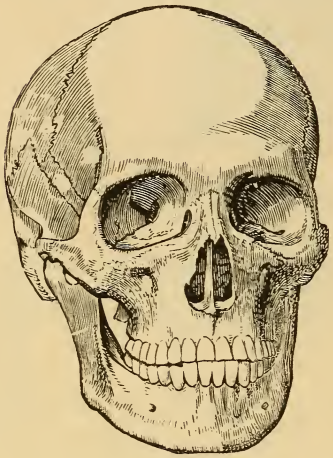

Fig. 2.

THE SKULL AND FACE BONES, SHOWING THE TEETH.

The bones of the *face* are irregular in shape, and are firmly joined to form the nose, cheeks, and jaws.

A bone at the base of the tongue aids in moving the throat. Six tiny bones, three in each ear, aid in hearing.

The bones of the **trunk** form the *chest*, *spinal column*, and *pelvis*.

The *chest* is made of twenty-four ribs, twelve on each side, forming a bony cage for the heart and lungs. The ribs are joined behind to the spinal column, and in front to the sternum or breast-bone by means of cartilage or gristle, excepting the lowest two ribs on each side, which at the front are free. The ribs aid in moving the chest when we breathe. (See Fig. 3.)

The *spinal column* consists of twenty-four bones called vertebræ, placed one upon another, with pads of cartilage between them. Cartilage is an elastic substance, somewhat like rubber. It is used between the bones in forming the joints to prevent

jar and wear. It is used elsewhere in the body

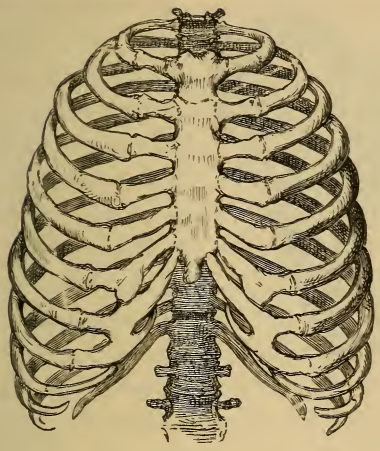

Fig. 3.

THE RIBS AND PART OF THE SPINAL COLUMN.

when there is need of a substance that is firm and elastic. This column of bones is extremely strong, and yet it may easily be bent in any direction. By the aid of the muscles it supports the head, and holds the trunk in position. It also protects the spinal cord which lies within it. (See Fig. 4.)

Fig. 4.

SPINAL COLUMN.

The *pelvis* (see Fig. 5) is formed of large bones firmly united in the form of a basin. It gives shape and support to the lower part of the trunk. The spinal column rests upon the pelvis, and the pelvis rests upon the two lower extremities. (See Fig. 1.)

The bones of the **upper extremities** form the shoulders, arms, and hands. A flat, broad bone, called the *shoulder-blade*, forms the back of each shoulder, and a long, curved bone, called the *collar-bone*, braces the shoulder in front. These two bones join at the point of the shoulder. A single long bone, called the *humerus*, reaches from the shoulder to the elbow. Two slender bones, side by side, form the fore-arm from the elbow to the wrist. The bone on the inner side is called the *ulna;* the outer is known as the *radius*, because it twists about the ulna in turning the hand. (See Fig. 7.) At the wrist there are eight small, pebble-shaped bones; in the palm of the hand there are five bones; and in the fingers of each hand, fourteen.

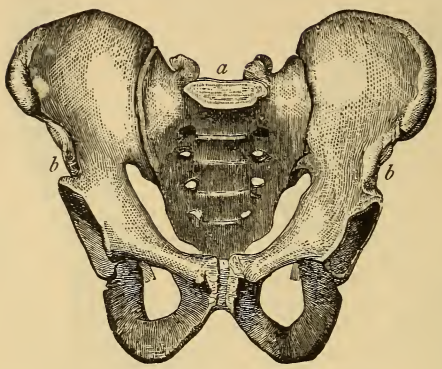

Fig. 5.

Bones of Pelvis.

a, sacrum; *b*, hip-bones.

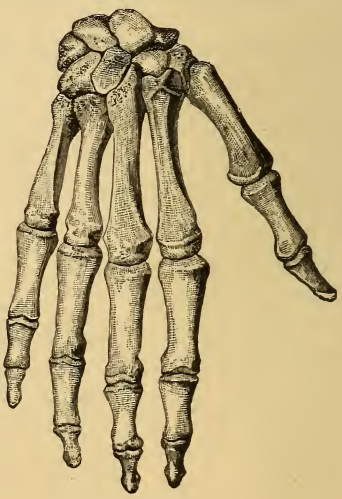

Fig. 6.

Bones of the Hand

The bones of the **lower extremities** are fitted into the pelvis to give support in standing and walking. The large thigh-bone, called the *femur*, extending from the pelvis to the knee, is the longest bone of the body. A small, oval bone fits over the knee in front. Two bones, side by side, known as the *tibia* and *fibula*, form the leg below the knee. (See Fig. 8.) The ankle has seven bones, which, with the five in the ball of the foot, form the instep, on which we bear our weight. There are fourteen bones in the toes of each foot.

Fig. 7.

BONES OF ARM AND FORE-ARM.

a, humerus; *b*, ulna; *c*, radius.

Fig. 8.

BONES OF THIGH AND LEG.

a, femur; *b*, fibula; *c*, tibia.

The bones are composed of two kinds of matter: (1) a hard substance, which is the mineral part; and (2) a jelly-like substance, which is the animal part. If we burn a bone in a slow fire, *the animal portion will be driven off* by the heat, and the mineral part, which forms about two thirds of the bone, will

remain in the form of a white, brittle body resembling chalk. By putting a fresh bone in weak acid for several hours, *the mineral part will be dissolved*, and the animal portion will remain, having the shape and size of the original bone, but so soft that it may be tied in a knot.

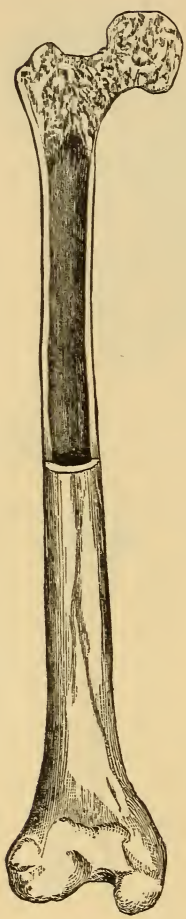

Fig. 9.

STRUCTURE OF BONE.

The mineral substance makes the bones hard and firm; the animal portion prevents their being brittle, and makes them slightly elastic. The bones of children have less of the mineral matter in them, and do not break so easily as do those of old people, whose bones have become brittle because they contain less of the animal substance.

In infancy the bones are soft, and formed only of animal substance. As they need to become stronger, they take mineral matter from the blood and build it into themselves until they become very hard.

The bones are not solid throughout; they are very hard in the outer portion, but the inside of a bone is spongy or hollow. (See Fig. 9.) The hollow portions are filled with a fatty substance called marrow. Thus the bones are large and strong, but not heavy. They are almost as strong as iron, yet nearly as light as wood.

In cases where the bones are not intended to move on one another, they are joined in firm seams, as in the skull, or fastened solidly together like the parts of the pelvis. (See Figs. 1 and 5.) But wherever motion is needed, the bones are united in the nicest manner to form **joints,** so that one bone fits perfectly into the other and permits just the motion required.

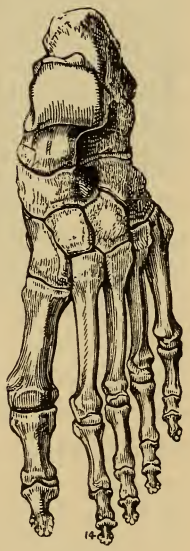

Fig. 10.
BONES OF LEFT FOOT.

At the joints, the ends of the bones are tipped with elastic *cartilage* to prevent the jar and wear there would be if the bones rubbed against each other. This cartilage is covered with a very smooth coating called the *synovial membrane*, that keeps the joint moist, so that it moves with perfect smoothness. The joints move so freely that we do not feel their motion. The ends of the bones that form a joint are bound to each other by means of strong white bands, called *ligaments*. These ligaments prevent the ends of the bones from separating, and make the joints as strong as the other parts of the body. Fig. 10 shows the bones and joints of the left foot.

The joints are of several kinds. Some of them move only back and forth like the hinges of a door, and are for this reason called *hinge-joints*. The elbows and knees are of this kind. In some cases the round, ball-shaped head of one bone fits into a

cup or socket of another bone. Such joints are called *ball-and-socket joints*. The hip and shoulder joints are of this kind. In the wrists and ankles there are many small bones that move on one another, forming *compound joints* which have very free motion. The ulna and radius form *pivot-joints*, in which one bone turns around another.

The bones are so hard that we may wonder **how they grow.** Although they are firm and seem solid, they have tiny passages through them, so that the blood flows in them as it does in every other part of the body.

The bones are covered with a membrane, called the *periosteum*, which is the chief means of nourishing them. If the periosteum is destroyed, the bone dies.

Fractures.—When a bone is broken, the blood surrounds the broken ends with a thin, jelly-like substance, which grows harder each day by taking mineral matter into itself from the blood, until, finally, firm bone is formed, which binds the broken ends together. Sometimes the mended part is stronger than any other.

The bone ought to be put in proper position immediately after it is broken, and the parts held in their right place and shape until they have grown together firmly.

Sprains.—A joint is strong, but a sudden twist or a heavy fall may sprain it. This is a very painful injury, and will require a long time for its recovery. Sometimes the sprain is so severe that the ends of the bones slip apart. This weakens the joint very greatly. We should avoid dangerous climbing, jump-

ing from high places, and rough sports, lest we sprain our joints or break our bones.

We all admire the erect, manly form, with full chest, and shoulders well thrown back. If we wish to have such a form, we must be careful how we

Fig. 11.

PROPER AND IMPROPER POSITIONS IN SITTING AND STANDING.

stand and sit, for while we are young the frame of our body is growing, and our bones will easily take the shape we give them.

By holding the shoulders back and making the chest full, we have more room for the heart and lungs; we breathe more air and have better blood ; we have better health and greater strength. Stooping shoulders are caused by standing and sitting in a wrong position until the spinal column loses its right form.

Sometimes the bones are **pressed out of their right form** and caused to grow into an ugly shape.

Close-fitting shoes prevent the bones of the foot from growing in the right manner. We should wear easy-fitting shoes, with low heels and broad soles, so that our feet may be well formed and our step be firm and elastic.

Some foolish persons, in order to have small waists, press in their ribs with tight clothing. Such a waist does not correspond to the breadth of the shoulders. The condition of the parts of the body underneath the compressed ribs is painful to consider.

The customs of the Flathead Indians, who press the skulls of their children out of shape, and of the Chinese, who pinch the feet of their girls, are considered uncivilized, and are attributed to the ignorance of the people who practice them. Tight lacing is more injurious in its results, because it compresses the trunk of the body, in which are most of the vital organs.

Good food, and proper exercise in the open air are the best means to make the bones grow strong; the food furnishes the material, and the exercise causes the bones to use this nourishment in growing. Poor food and impure air make weak bones. Young children who have little exercise, who breathe impure air, and who are fed on food that does not nourish the bones, are often unable either to stand or to walk, because their bones are too weak to bear their weight.

Tobacco injures the blood, and thus tends to stop the growth of the bones. It is especially in-

jurious to boys, as they need a plentiful supply of good bone-building matter from the blood.

Alcoholic drinks of every kind are injurious to the blood, and prevent the proper growth of the bones. In the opinion of some physicians, they also injure the delicate covering of periosteum, and thus cause serious bone diseases. The growth of a child's bones may be so checked by alcohol that it will never attain its full size.

Gout, a very painful and often dangerous disease of the joints, is caused by the use of alcoholic drinks. A substance in the blood which settles around the joints and makes them very painful is often produced by the use of such drinks.

Summary for Review.

1. *What is the skeleton?*
   The bony frame-work of the body.
2. *What uses has the skeleton?*
   It supports, it protects, it gives shape, it aids in motion.
3. *How many bones are there?*
   Two hundred and six.
4. *Into what groups are the bones divided?*
   Those of the head, of the trunk, and of the extremities.
5. *What do the bones of the head form?*
   The skull and face.
6. *Of what is the skull formed?*
   Of broad, curved bones, to form a safe place for the brain.

7. *How are the bones of the face arranged?*
   To form the nose, cheeks, and jaws.
8. *What do the bones of the trunk form?*
   The chest, spinal column, and pelvis.
9. *How is the chest formed?*
   Of twelve ribs on each side, joined to the spinal column behind and to the breast-bone in front.
10. *What are the uses of the ribs?*
    They protect the heart and lungs, and aid in breathing.
11. *How is the spinal column formed?*
    Of twenty-four vertebræ, one upon another, with cartilage between.
12. *What are the uses of the spinal column?*
    To support the head and trunk, and to protect the spinal cord.
13. *How is the pelvis formed?*
    Of large bones firmly joined in the shape of a basin.
14. *What are the uses of the pelvis?*
    To support the spinal column, and the lower part of the trunk.
15. *How are the bones of the upper extremities arranged?*
    To form the shoulders, arms, and hands.
16. *How are the bones of the lower extremities arranged?*
    To form the thighs, legs, and feet.
17. *Of what are the bones composed?*
    Of animal and mineral matter.
18. *Are the bones solid?*
    They are not; the outer part is nearly solid, but the inner portion is hollow or has many openings.
19. *Why are the bones shaped in this way?*
    That they may have size and strength, without being too heavy.

20. *How are the ends of the bones shaped at the joints?*
So that one end fits nicely into the other.
21. *How are the ends covered?*
With cartilage and a smooth membrane.
22. *How are the bones of the joint bound together?*
By strong ligaments that reach from bone to bone.
23. *How are the bones covered?*
By the periosteum.
24. *What care should be taken with a broken bone?*
To put the broken ends in proper place, and keep the bone quiet until it grows strong again.
25. *How does pressure injure the bones?*
It gives them a wrong shape.
26. *How do tight shoes injure the feet?*
By pressing the bones out of shape.
27. *How are stooping shoulders caused?*
By standing and sitting in wrong positions.
28. *What are some of the effects of tight lacing?*
The ribs are contracted and pressed in upon parts of the body which they are designed to protect.
29. *How does tobacco affect the bones?*
It makes poor blood, and tends to stop the growth of the bones.
30. *Why should not a child drink alcoholic liquors?*
Because the growth of the bones may be so stopped or checked by alcohol that the child will never attain its full size.

CHAPTER III.

THE MUSCLES.

Definitions.

bī′çeps, a muscle having two heads.
eal is thĕn′ics, the science of the healthful exercise of the body.
fī′bers, the thread-like parts of any tissue.
sĕc′tion, a cutting through any substance to show how it looks, or what it is composed of.
sĕd′en ta ry, inactive, without bodily labor.
tĕn′don, a strong band joining a muscle to a bone.

THE fleshy parts of our bodies that we use whenever we move are our **muscles.** They pull the bones and bend the joints. They give the body its gracefulness, and its appearance of life and strength. (See Fig. 12.)

There are in each of our bodies more than five hundred muscles, so connected that we can make any motion that is needed. Many of them are arranged in pairs that are fastened on opposite sides of the bones, one to give motion in a certain direction, and the other to make the same bone move in the opposite direction.

We can make a muscle draw itself together so that it becomes shorter and harder; this is called *contracting* the muscle. (See Fig. 12.) We can let it become soft and return to its former shape; this is called *relax-*

ing the muscle. In the diagram the dotted lines show the changed shape of a muscle when contracted, and also the changed position of the parts with which the muscle is connected.

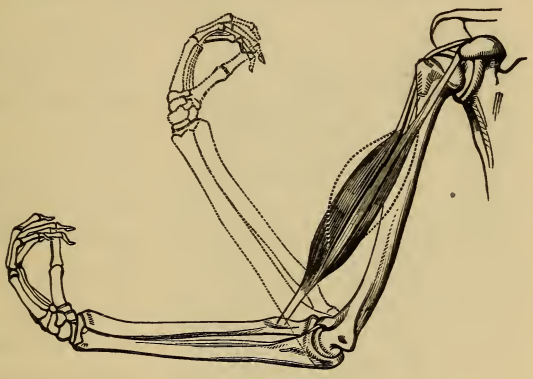

Fig. 12.

DIAGRAM TO SHOW MUSCULAR ACTION.

It is by contracting the muscles that we make them move the bones to which they are fastened. We can feel the biceps muscle of the arm as it contracts into a short, hard mass in order to raise the hand, and as it relaxes to let the hand down again. All our movements are produced by the contraction and relaxation of muscles.

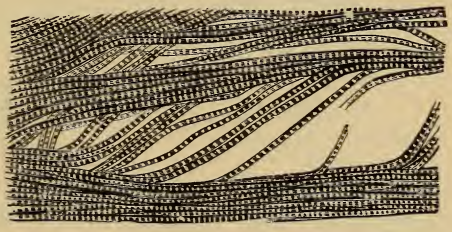

Fig 13.

SMALL FIBERS OF MUSCLE, HIGHLY MAGNIFIED.

Composition of the Muscles.—The muscles are composed of thin layers, and small bundles of fleshy *fibers* which extend through them. These bundles are in turn made up of still smaller fibers. (See Fig. 13.) All these parts of the muscle

are covered with thin coats of tough membrane which bind them together and make the muscle strong.

The muscles that move the bones usually end in tough, white cords, called *tendons*, that are fastened to the substance of the bones. The muscles of the body are like the lean meat we use for food. We may pull beef or mutton to pieces and see how the bundles of fibers are arranged. We may also see how the tendon joins at one end to the muscle, and at the other to the bone. (See Fig. 12.)

Fig. 14.

MUSCLE.

In **shape,** many of the muscles of the extremities are long and tapering; those of the trunk are broad; others are in the shape of rings and tubes. The muscles of the heart and stomach are hollow.

Exercise of the Muscles.—If we use our muscles properly, they will become strong. The muscles we use most are the strongest, provided we do not use them too much. The arm that we use most is the stronger. The arms of carpenters and

blacksmiths are very strong because they use them so much.

Exercise causes more blood to flow to the muscles, and thus they take more nourishment from it with which to grow and become strong. After the muscles have been properly exercised, they must have *rest;* to use them too long or too severely will make them tired and weak.

Soldiers are made strong for their work by daily drills and marches. Sailors are made hardy by exercises in climbing, lifting, and pulling. Men are prepared for races and tests of strength by exercising in the open air. Thus, boatmen make their bodies strong by rowing, bicycle riders practice riding, ball players gain strength by batting, catching, and running. In all these cases, the men are careful to exercise at the right time and in the proper manner. *They do enough, but not too much.*

Fig. 15.
EXERCISE OF THE MUSCLES.

Brisk walking, in clothing loose about the body, is a simple and excellent exercise. Active out-door play is the best of all for girls and boys. If our work requires us to sit, we should seek relief in walking. If we use one set of muscles in work, *we should employ a different set in exercising.* If we are confined indoors at study we should take abundant exercise in the open air for a change.

We are likely to exercise more *by having an interesting object in view.* We soon tire of walking if we have no purpose to serve by it, whereas we often walk long distances to see an interesting sight without being weary. We enjoy exercise more with companions than when alone. *Calisthenics* are valuable because they call the various muscles into action at regular intervals, followed by suitable rests. They tend to give ease and gracefulness of motion. They tend, also, to give us better control of our muscles.

Rules for Exercise.—

Exercise pleasantly and regularly every day.

Exercise in the open air and sunlight.

Exercise moderately rather than violently.

Use many muscles at a time.

Change often from one kind of action to another.

Do not exercise too long without rest.

Do not sit or lie on the ground to rest.

Do not try to do what is beyond your strength.

Do not exercise vigorously just before or just after eating.

How Alcohol Affects the Muscles.—The thin, tough skin, called *connective tissue*, which surrounds the layers of muscles and binds them together, also runs through most of the organs of the body as a fine network. When the cook cuts up pieces of suet, you may recognize this connective tissue as a stringy membrane penetrating it in all directions. The use of any alcoholic drink tends to *increase the growth of this tissue* to such an extent that it crowds and weakens the muscles.

Alcohol also often causes an *increase of fat* in the

muscles of the drinker, which greatly weakens them. Beer, of all alcoholic drinks, is most apt to produce this worse than useless fat. The muscles of the heart sometimes become so clogged with fat from the same cause that the heart can not perform its work, and it suddenly stops, ending the life thus shortened by alcohol.

If we examine with a microscope a very fine section of muscle taken from a man in good health, we find it firm, elastic, and of a bright red color, made up of parallel fibers with beautiful crossings. If we similarly examine the muscles of a man who leads an idle, sedentary life, and indulges in alcoholic drinks, we detect at once a pale, flabby, inelastic, oily appearance.

By experiment, it has been proven that a man can not lift as heavy a weight after he has taken alcoholic drink as before. He may think he can, because alcohol deadens his feelings, making him unconscious of weakness or strength. It has been found that soldiers who have to march, men who have to walk long distances against time, or to row with great force and rapidity as boat crews do, carry out their work much better when they avoid every drink containing alcohol.

Strong and steady muscles that unflinchingly obey the will are necessary for skilled workmanship. Alcohol not only weakens the muscles, but renders them unsteady, and unfit for exact service in the handling of delicate tools for fine work.

Tobacco also will diminish muscular strength and precision. It is rigidly prohibited to an athlete or

an oarsman in training for a contest, in which the man of the strongest muscles under the most perfect control is likely to win. A marksman who has been a fine shot may lose his skill through the use of tobacco, which has made his muscles unreliable.

Summary for Review.

1. *How many muscles are there?*
   Over five hundred.
2. *Why are they usually arranged in pairs?*
   To move the parts back and forth.
3. *What is contracting a muscle?*
   Causing it to become shorter and harder.
4. *What is relaxing a muscle?*
   Permitting it to return to the former shape and size.
5. *How do we make the muscles move the bones?*
   By contracting them.
6. *Of what are the muscles composed?*
   Of layers and bundles of fleshy fibers.
7. *What are the tendons?*
   The strong white cords that join the muscles to the bones.
8. *Which of our arms is the stronger?*
   The one we use most.
9. *What men are strongest?*
   Those that work at healthful labor in the open air.
10. *What do the muscles need after being used?*
    They need proper rest.
11. *How are men prepared for feats of strength?*
    By regular exercises.
12. *In what ways are they careful in training?*
    To exercise in the right manner; to do enough, but not too much.

13. *How should exercise differ from work?*
By using such muscles as our work does not employ.
14. *What are some of the best means of taking exercise?*
Brisk walking and active play.
15. *Why are calisthenics valuable?*
Because they give the muscles regular exercises and proper rests.
16. *How may we injure the muscles?*
By using them too continuously or too severely.
17. *How may we take cold from exercise?*
By getting too warm and by cooling off too quickly, or by sitting or lying on the ground to rest.
18. *What is connective tissue?*
The thin, tough skin that surrounds the layers of muscles and binds them together.
19. *What effect do alcoholic drinks have upon this tissue?*
They greatly increase its growth.
20. *What harm is done by this?*
The muscle is crowded and weakened by the undue amount of tissue.
21. *What other damage to the muscle is caused by alcohol?*
An unhealthy growth of fat is produced.
22. *What harm does this do?*
The muscle is weakened by it.
23. *What kind of muscles are needed for skilled workmanship?*
Strong and steady muscles that unflinchingly obey the will.
24. *What effect has alcohol upon the steadiness of muscles?*
It renders muscles unsteady, and unfits them for handling delicate tools or doing fine work.
25. *What effect has tobacco upon the muscles?*
It also diminishes their strength and steadiness.

CHAPTER IV.

THE SKIN.

Definitions.

ab sôrb′, to take up, as water by a sponge.

cū′tis, the sensitive inner, or true, skin.

cū′ti cle, the dry outer skin; the scarf-skin.

e văp o rā′tion, the change of a fluid to a vapor or gas.

glănds, cells that draw out various substances from the blood.

pōres, minute openings in the skin.

The skin forms a soft, strong cover for the body. It is composed of two layers: (1) the outer portion, called the *cuticle*, and (2) the inner part, called the *cutis*.

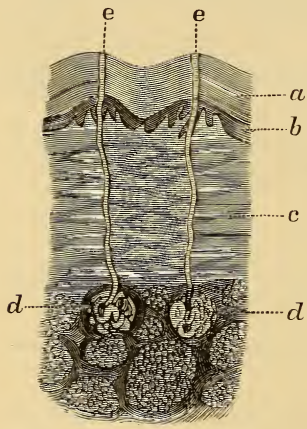

Fig. 16.

Section of Skin.

a, cuticle; *b*, coloring-matter; *c*, cutis; *d*, sweat glands; *e*, pores.

The cuticle is the part we see and touch. It is strong, and does not bleed or give us pain when injured. It protects the cutis, and permits us to handle ordinary objects without pain. The cuticle grows out of, and upon the cutis, and is continually wearing off as dry scales on the outer surface; by this change it is made new for us

every few days. On the inner side of the cuticle there are some grains of *coloring-matter* that give complexion to the skin. The color of the different races of men depends upon the amount of coloring-matter in the skin. In white races there is little of this substance; in dark races there is much. Exposure to the sunlight makes the skin darker; for this reason we are tanned in the summer.

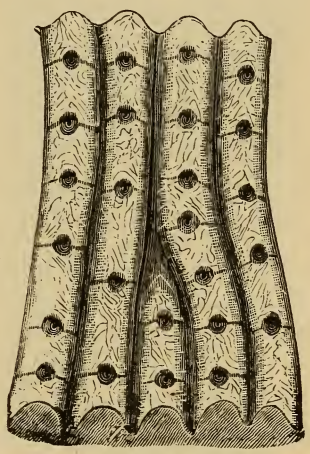

Fig. 17.

PORES OF THE PALM, HIGHLY MAGNIFIED.

The cutis, or inner layer, is the true skin. It is very tough, and, with the aid of the cuticle, protects the delicate parts under it from injury. The cutis has nerves in it by which we feel when anything touches us.

The cutis will bleed if we pierce or cut it, because it is filled with tiny blood-vessels. It is the blood that gives the pink color to the skin, the rosy flush to the cheek, and the redness to the lips. The skin is warmed and nourished by the blood. If we were to examine the skin with a strong magnifying glass, we could see that it has very many tiny holes or *pores* in it. These pores are the open ends of small tubes that are coiled into little glands which are buried in the skin (Figs. 16 and 17). They are called *sweat glands.*

These sweat glands are so closely surrounded by

the blood-vessels of the skin that some of the salty water of the blood is constantly passing out through these glands, and escaping into the air. This water from the blood is called perspiration, or sweat.

Perspiration takes place at all times, though we may not see it. In this way, more than a pint of water and some salts are thrown off daily as impurities from the blood. By this action of the skin it aids other organs in purifying the blood.

When we exercise or from any cause become very warm, more blood flows to the skin, and the little glands open, so that we perspire more freely. In such cases the perspiration runs out so fast that it wets the skin and makes us cool. It is the evaporation of the water that cools the skin, and blood. The perspiration turns from water to vapor, and in so doing absorbs heat from the skin.

It is the skin that regulates the warmth of the body; when we are cold, it closes its pores and becomes a dry, warm cover; when we are warm, it opens its pores and becomes a wet, cooling garment. Thus we see how important the skin is.

It protects us from injury.

It gives us feeling.

It aids in warming us when we are cold.

It cools us when we are warm.

It helps to purify the blood.

The hair is a part of the skin, and grows from it as the cuticle does. It serves in part as a protection. The old scales of the cuticle form dandruff on the scalp. *Oil glands* in the skin pour their oil upon the hair to keep it soft and glossy. We should keep

the scalp clean, and we may do so ordinarily by using the brush and comb rightly; if they are not sufficient, we should wash the scalp clean as often as is necessary.

The nails also grow from the skin. They give firmness to the tips of the fingers, and enable us to pick up small objects; they also protect the ends of the toes and fingers from injury. We should keep the nails clean and clipped. We should not scrape them, but use a brush, if necessary, to cleanse their edges.

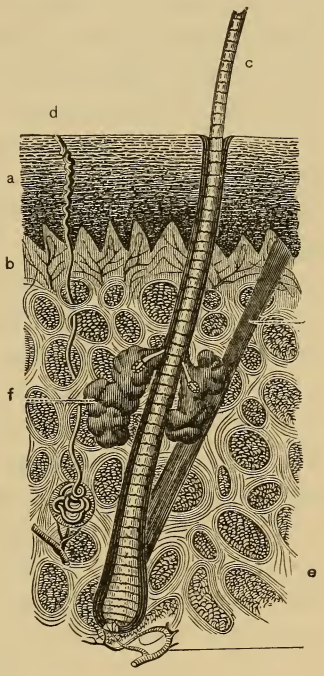

Fig. 18.

SECTION OF SKIN, SHOWING HAIR.

a, cuticle; *b* and all below, cutis; *c*, a hair; *d*, duct of sweat gland; *e*, fat; *f*, oil gland.

Cleanliness of the Skin.—We should keep the skin clean and its pores open so that it may do its part in purifying the blood. A clean, healthy, active skin is one of the surest safeguards against disease.

We need to *bathe* often. In most cases a daily bath is required. In bathing, we should use enough water and soap to loosen the oily substances, and should rub the surface well with cloth or brush to take off the dead scales of the cuticle. We should then dry well and make the skin glow with warmth.

The water and air may make us chilly at first, but the exercise and friction in rubbing and drying the body will warm us again. This warm feeling which follows bathing is called a reaction. When a reaction follows bathing, there is little danger of taking cold. If from any cause we can not produce this reaction, it is better not to bathe.

A quick bath in cool water, with proper rubbing, helps to make the skin strong, and aids in preventing us from taking cold. Warm or hot bathing makes the skin delicate. We should avoid bathing immediately after a hearty meal, or when very tired or very warm, or when we are feeling cold. We should not remain in the water very long.

Clothing keeps us warm by shielding us from the cold air. There is no warmth in the clothing itself. The heat is in the body, and the clothing simply prevents it from escaping too rapidly.

Woolen is best for winter wear. Soft flannel worn next to the skin is the best protection against severe cold and sudden changes of temperature. Loose clothing is warmer than that which fits closely. In exposure to very cold weather, we should dress the hands and feet as carefully as we do other parts of the body.

Clothing absorbs moisture and other impurities from the skin, and should, therefore, be frequently changed. When we go to bed we should remove all the clothing worn during the day. In the morning the bedding should be thoroughly aired before the bed is made up.

It is dangerous to permit damp clothing to dry

upon the body, and to sit with wet feet, or with damp clothing about the ankles. Rubber overshoes and overdress should be removed when we come indoors.

What we call a *cold* generally comes from a feeble condition of the skin, from sudden exposure, or from chilling some part of the body. As the skin does not perform its work properly, the blood becomes impure, and the lungs and other organs are injured by overwork.

The skin is injured by the use of **alcoholic liquors.** The small blood-vessels of the skin distend, and become overcharged with blood. This gives the skin a red and inflamed appearance. The proper nourishment of the skin is prevented; it becomes scaly, and the sweat glands do not perform their work. What they leave undone falls upon the already overworked kidneys, and so helps to make them diseased.

Summary for Review.

1. *Of what is the skin composed?*
   The cuticle and the cutis.
2. *What is the cuticle?*
   The outer layer that protects the cutis.
3. *What gives color to the skin?*
   A substance in the cuticle.
4. *What is the cutis?*
   The true skin that forms the inner layer, and that contains the nerves and blood-vessels.
5. *For what are the nerves of the skin?*
   To feel any thing that touches us.

6. *What are the pores of the skin?*
   The tiny tubes that open on the surface.
7. *What is the use of the pores?*
   They permit the perspiration and other impurities of the blood to escape.
8. *How does the skin regulate the heat of the body?*
   By becoming wet to cool us when we are too warm, and by being a dry, warm cover for us when we are cold.
9. *What can you say of the hair?*
   It grows out of the skin, and is made glossy by oil-glands in the cutis.
10. *What of the nails?*
    They, also, grow from the skin, and give firmness and protection to the ends of the fingers and toes.
11. *How may we avoid taking cold from bathing?*
    By drying all parts well, and rubbing enough to cause a reaction.
12. *When should we not bathe?*
    When very warm or tired.
13. *What is the best material for winter clothing?*
    Woolen.
14. *How does the underclothing become unclean?*
    By absorbing the impurities from the skin.
15. *How do we take cold?*
    By chilling some part of the body.
16. *Why does a cold affect the lungs?*
    Because the pores of the skin are closed, and the lungs, which help to throw off impurities from the blood, are overworked.
17. *How is the skin injured by the use of liquor?*
    The sweat glands do not work freely.

18. *What controls the movement of the blood in the blood-vessels?*

The nerves that lead to them.

19. *How does alcohol interfere with this?*

It paralyzes these nerves, letting the blood-vessels become permanently expanded, as in the red nose of the habitual drinker.

20. *With what does this condition of the blood-vessels interfere?*

With the proper nourishment of the skin.

21. *What is the result of this?*

The skin does not remove the impurities from the body as it should.

22. *Upon what other organs does the work then fall?*

Upon the kidneys, which are then made more liable to disease, from overwork.

CHAPTER V.

FOOD.

Definitions.

al bū'mi noid, like white of eggs.
al lāy', pacify, check, repress.
diş şŏlve', to change to a liquid form; to make into a solution.
ġĕrm, that from which anything springs ; a minute organism.
nū'tri ment, whatever nourishes; food.
păr'a sīte, any animal that lives upon the body of another animal.
tȳ'phoid, a kind of fever.

We must have food in order to live; it supplies the new matter for the growth and repair of the body, and furnishes the material that is sometimes called fuel because of the purpose it serves in keeping the blood warm. Without solid food, men die of starvation in a short time. Without water, we should soon perish of thirst.

There are many common articles that serve for food. The flesh of animals, the grains of the field, the vegetables of the garden, and the fruits of the orchard give us a great variety of things good to eat.

These common articles may be divided into the following kinds:

1. albuminoid foods;
2. starch and sugar foods;
3. fatty foods;
4. mineral foods.

The most valuable foods are **albuminoids** because they serve best to renew the wasted parts and restore the strength of the whole body. They are good for those who work hard, or who take much exercise. They are needed, too, by growing children. They are called albuminoids because they contain substances that resemble the albumen of white of egg. The most common articles of this kind are lean meat, eggs, fish, beans, and milk.

The *flesh* of healthy animals is good food. It should always be well cooked, as it sometimes contains germs of disease and very small living things called parasites, which are dangerous to life if taken in food. *Beef*, *mutton*, *chickens*, and *turkey* are among the best of meats. *Veal* and *lamb* are less nutritious and more difficult to digest than the flesh of older animals. Lean *pork* is not so good for food as lean *beef*. Pork contains too much fat for constant use, and is more likely to be diseased, or to contain the germs of parasites. In any case, it should be well cooked before it is eaten. Smoking and salting do not destroy the germs of disease, so that salt pork is unsafe if eaten without being cooked.

The flesh of healthy animals is free from spots; the lean parts are uniform in appearance and equally firm to the touch. Meats that are spotted when freshly cut, or that are clammy to the touch, are unfit for food.

Pure *milk* and fresh *eggs* are almost perfect food, and may be used in any way the taste prefers. Milk is chiefly water, but also contains the albuminoid portion that forms cheese, and the oily part that

makes butter. Milk should be used only from healthy animals that are fed on sound and wholesome food, and that live in the open air. Foul milk will cause sickness as surely as will impure water. Fresh *fish* and *oysters* rank among the best of foods. They are rich in nourishment, and easily digested.

The starch and sugar foods are so called because they contain much starch and sugar. They are almost as valuable as the albuminoids, for they both nourish and warm the body. We obtain them in great abundance at small cost. They are easily prepared for the table, and when eaten, they readily form rich, new blood. Starch and sugar have nearly the same composition. The starch we eat is changed to sugar by the digestive fluids before it enters our blood.

Wheat, *oats*, *corn*, and *barley* are rich in starch. These grains are among our chief sources of food. Wheat is rich both in albuminoid food and in starch. It is the most valuable of all the grains.

Wheat bread is one of the most important articles of food; it is the one thing that is ordinarily provided for each meal of the day and for every family. It is rich in nutritious matter, pleasant to the taste, and easy of digestion. If made of "whole wheat" flour, and eaten with butter, it is almost a perfect diet for people who live in temperate climates. Wheat bread alone will support life longer than any other kind of food, except milk.

Light bread is much more easily digested than that which is heavy, and well-done bread is better than that which is imperfectly baked. Fresh, hot

bread is apt to make a pasty mass in the stomach, and is not as wholesome as bread which has had time to cool.

Graham bread is made from flour in which some of the bran of the wheat has been retained; it is

Fig. 19.

GATHERING THE WHEAT.

sweeter than white bread, and contains more of the albuminous portion of the wheat. We use corn not only for food, but we make starch from it for various other uses.

Rice is almost wholly starch. In some parts of the world it is the chief article of food. Perhaps more

people live upon rice than upon any other single kind of grain.

Pease and *beans* form very nutritious food, for they are rich in both albumen and starch. *Potatoes* contain scarcely any thing but starch and water. Beets, cabbages, turnips, and other garden products contain much water, together with starch and sugar.

Fruits contain a small quantity of starch. As the fruit ripens, this starch turns to sugar. Fruits are not as nutritious as the starchy grains. In addition to their sugar, the fruits contain some salts and acids that we need. Their spicy taste and odor please us, and they excite the stomach in such a way as to aid the digestion of other food. Ripe fruits in season should always form part of our diet. Their regular use in moderate quantities aids greatly in keeping us in good health. Unripe fruit is made eatable by cooking. Fruit that has been kept in cans or other metallic vessels until it has a bad odor or taste, should not be eaten.

The *sugar* we buy for the table is usually made from the juice of the sugar-cane. The canes are crushed between rollers that press out the sweet juice. By boiling this juice, much of the water is driven off and the sugar and molasses are left in the pan. In some countries sugar is made from beets. Melons have much sugar in them; so have grapes. Honey, which is made by bees from the juices and gums of flowers, is nearly pure sugar. Candy is made from sugar or molasses. In the making of candy, various substances are added to the sugar to give flavor and color. Pure candies are no more harmful

than sugar, but substances unfit to eat are often used in making candy. Clay is used to adulterate the sugar in very cheap candies; sometimes poisonous substances are used to give bright colors. We should avoid the colored candies, and in any case eat of candy but sparingly.

The fatty foods are obtained from the fat of animals, and from the oils of grains, seeds, and nuts. We use these fatty foods to keep up the heat of the body. The people of arctic countries live chiefly on the fat of seals and other animals. Fat to them is as delicious as sugar is to us. Such food enables them to bear the great cold. We need some fatty food at all times, but we need it most and like it best in winter.

Tallow is made from the fat of beef and mutton. Lard is made from the fat of pork. Butter is made from the cream of milk, and is nearly pure fat.

Water and Salts.—In the foods we eat there are various kinds of salt, some of which we need for growth and repair. There are salts of iron and lime in all meats and grains, and in the water of most springs and wells. The iron we get from food seems to benefit the blood, and the lime aids in building up the bones.

We especially need *common salt*, such as we use for seasoning food. There is not so much of this in our food as we desire, so that we usually add some in preparing the food to eat. When men are deprived of salt, they become very hungry for it. If used in moderate quantities, it aids in keeping us in good health. Too much salt causes thirst, and is injurious

in other ways. The animals of the farm thrive better by having a little salt. The wild deer and buffalo will travel long distances to find what are called "salt-licks." Common salt is obtained in vast quantities from mines. It is also taken from the water of the sea and of salt-springs.

Water is the chief part of the blood, brain, muscles, and other softer parts of the body. We need to take about three pints of water daily either as drink or in the juices of food. Thirst tells us when we are in need of water. Water is the natural drink. It is clear and free from odor or taste. Rain-water is nearly pure. The water of clear, cold springs and deep wells is more apt to be pure than that which comes from the surface of the ground.

We should use good water if we hope to have good health. We should not drink water from shallow wells, from unclean or leaky cisterns, or from any source that is near to stables, vaults, or sewers. Wells twenty feet deep or less are shallow. Wells should not be less than seventy-five feet from vaults of any kind. In cities it is almost impossible to get pure water from wells unless they are driven to a great depth, and unless the water near the surface is entirely excluded. Sickness, such as typhoid fever and diphtheria, is often caused by drinking foul water.

Fig. 20.

A Drop of Impure Water.
(Magnified.)

Water that has a tainted odor or taste, or that produces a scum when boiled, is unfit for use. Large cities are in some cases supplied with drinking water from adjacent rivers. Such water contains some of the impurities of the river. Boiling and filtering will do much to rid water of any impurities it may contain. Filtering will make water clear, and remove an offensive odor; but the germs of disease, which are the most dangerous of impurities, may pass through the filter. These germs may exist in water that is clear, and free from odor. Boiling destroys them and makes the water safe to use. Ice-water should be used sparingly as drink. Cold drink checks digestion until the contents of the stomach become warm again. A moderate quantity of warm drink aids digestion.

Spices and Condiments.—We often add to our food such things as pepper, spices, and vinegar. These are not in themselves nutritious foods. Small quantities of them do little harm, though they may tempt us to eat too much. Pickles are not wholesome food. We like them because they are sour. The acid fruits, such as lemons and limes, are better for us.

Highly-seasoned food can not fail to excite the stomach and intestines, and is therefore more or less injurious. By the habitual use of condiments we lose our taste for plain food.

Cooking makes our food more inviting, more tender, and more easily digested. It changes the appearance of food and develops its flavors. Thus, raw beef has but slight odor or taste, but when cooked it is pleasing to our senses.

Food is often *roasted* in an oven. This is an excellent way of cooking, especially for all kinds of meats. Broiling is also a good method of cooking meats.

Boiled food is tender, but water mixed with the food changes its taste, and dissolves some of the parts.

Frying is the most objectionable way of cooking. If meat, potatoes, or other food is fried, the hot fat mixes with it, and makes a greasy mass that is not easy to digest. Many persons can not eat fried food.

Summary for Review.

1. *Why do we need food?*
   For growth, repair, and warmth.
2. *What are the kinds of food?*
   Albuminoid, starch and sugar, fatty and mineral.
3. *What are albuminoid foods?*
   Such as are rich in some kind of albumen.
4. *Why are they valuable?*
   Because they renew the parts of the body.
5. *What are the principal articles of this kind?*
   Eggs, meat, fish, beans, and milk.
6. *Why are starch and sugar foods valuable?*
   They both nourish and warm the body.
7. *Why are they so generally used?*
   Because they are abundant and cheap.
8. *What are the principal articles of this kind?*
   Wheat, corn, rice, and potatoes.
9. *From what is sugar usually made?*
   From the juice of the sugar-cane.
10. *What is the use of fatty foods?*
    To serve as fuel in keeping the blood warm.

11. *When do we need such food most?*
In cold weather.
12. *Name some mineral foods.*
Common salt, and the salts of iron and lime.
13. *Why do we add common salt to our food?*
Because there is not so much in our food as we need.
14. *What is said of the use of strong seasoning?*
Much strong seasoning in food is injurious.
15. *Why do we cook food?*
To improve its taste and make it more easy of digestion.
16. *How is food usually cooked?*
It is roasted, boiled, broiled, or fried.
17. *What is the objection to frying food?*
It mixes the food with hot grease and makes it difficult to digest.
18. *Why is wheat bread good food?*
It is very nutritious, pleasant to the taste, and easy to digest.
19. *What makes bread light?*
The yeast ferments the sugar of the flour, and causes bubbles of gas to make the bread light.
20. *Why should meat be well cooked?*
To kill any germs of disease or parasites that may be in it.
21. *What are the best kinds of meat?*
Beef, mutton, chicken, and turkey.
22. *What kinds of meat should we not eat?*
Meat that is spotted, or clammy to the touch.
23. *How much drink do we need?*
About three pints daily.
24. *What is the proper drink?*
Water.

25. *What water is safest to drink?*
Rain-water, and such as comes from clear, cold springs and deep wells.

26. *How may we know pure water?*
It is clear and odorless, and will not form a scum when it is boiled.

27. *What will improve water?*
Boiling and filtering.

28. *Why should we use but little ice-water?*
It is too cold for the stomach.

CHAPTER VI.

POISONS.

Definitions.

a çĕt′ie, acid, sour.
af fĭn′i ty, attraction.
glū′cōse, sugar obtained from fruits, honey, and starch.
när cŏt′ie, any drug which allays pain, and which may produce stupor.
te năç′i ty, the quality of holding fast to.
vī′noŭs, pertaining to wine.

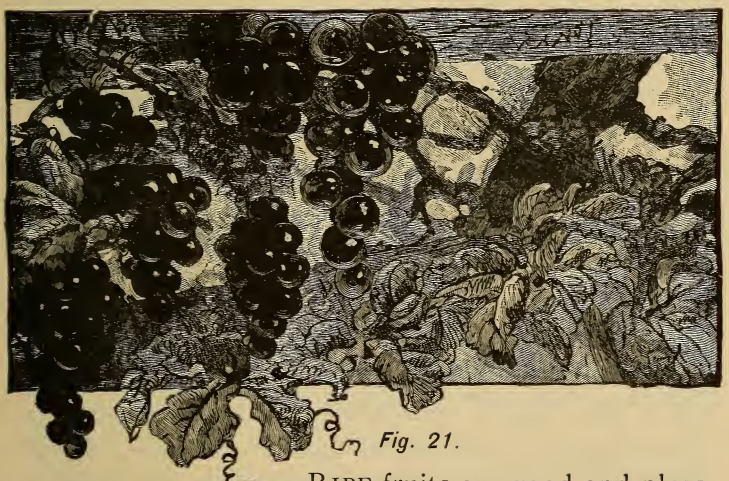

Fig. 21.

RIPE fruits are good and pleasant to eat. The juices of these fruits are sometimes pressed out and used as drinks. The juice is a healthful and delicious part of ripe fruit while it is protected by the skin of the fruit from any thing

outside; but when it is drawn off and left exposed to the warm, open air, a change quickly takes place that entirely alters its character.

Something called a **ferment,** that is too small to be seen by the naked eye, is found floating in the air. Such ferments turn good fruit juices to *poisons.* By the aid of the microscope one may see them resting on the skin of the grape and other fruits, but they can not get in to do their work until the juice is drawn off from the fruit. Then the ferments are quickly carried into such a fluid either from the skin of the fruit or from the air.

Fruits and plants get their sweet taste from the sugar, which, with their own peculiar flavor, and water, makes up their juices. The sugar we use upon the table and elsewhere comes from boiling down such juices. Ferments change fruit and plant juices to a poison by acting on this sugar. They will not attack dry sugar, nor a sirup that has an excess of sugar.

But in the fruit juice as it is first pressed out, the sweet principle of the fruit, or its sugar, is dissolved in watery juice, and ordinarily in just the right proportions for the ferments. If this liquid is moderately warm, the ferments will at once begin to work upon the sugar, turning it into two other substances, namely, *carbonic acid gas* and *alcohol.* Much of this gas passes in bubbles up through the liquid and escapes into the air, carrying a froth to the top. The alcohol remains in the fluid. It is a colorless liquid poison. Its presence turns what was good fruit juice into a poisonous liquid.

The work which these ferments thus do in the fruit juice is called **fermentation.** There are many kinds of fermentation. The one we have just described is called *vinous fermentation*—the change of the sugar in a fermentable liquid into alcohol and carbonic acid gas.

We see that vinous fermentation takes place when sugar, water, heat, a ferment, and air are all present in the right proportions. All these conditions usually exist when the fruit juice is drawn off and left exposed to the summer air.

Men were once ignorant of the fact that fermentation *entirely changes the nature* of any substance that it works upon. They thought that because fruit is good for food, the drink made from its juice, even if fermented, must also be good. They were mistaken. We now know that fermentation entirely changes the nature of the substance upon which it acts. In this case, it turns a food to a poison.

In the preparation of food, *vinous fermentation may be a benefit* if it is stopped at the right point, and if all the alcohol produced by it is driven off by heat.

In flour made from grain, there is a little sugar called glucose. When such flour is mixed with water, and *yeast* is added, if the whole is kept warm, the yeast, which is one kind of ferment, will begin to act on the sugar, turning it into alcohol and carbonic acid gas. This gas quickly passes off into the air from a thin liquid; but when held in by the sticky dough it puffs the dough up, making what the housekeepers call light bread. At last this gas

escapes in the oven when the bread is baked. The heat of the oven also causes the alcohol to evaporate and pass out of the bread in the form of vapor. A light and spongy loaf is left, in which there is no alcohol.

It was once thought that because a little alcohol is formed in the making of bread, and bread is good, that therefore fermented liquors containing alcohol must also be good. This is a mistake. The alcohol stays in the fermented liquors, but does not remain in the bread; therefore such liquors are poisonous while the bread is good.

Alcohol looks like water; but it is not at all like it. It burns with a bluish flame and without soot; it will dissolve gums and resins; it is a poison. All substances classed as poisons may not kill at once if taken in small quantities and not very frequently; they act as slow poisons. It is the nature of alcohol not only to injure health, but also to destroy character through its action on the brain. It does this in proportion to the amount taken. If a sufficient quantity of alcohol is taken at one time, or in repeated doses at brief intervals, it will destroy life.

Alcohol has a great affinity for water, and the two will mix whenever they meet. This is one reason why it does so much harm in our bodies when taken even in small quantities. About seven parts out of eight of the body, by weight, are water. The brain has 789 parts water out of 1,000; the muscles, 750 parts; the blood, 795. The fluids of the mouth and stomach are composed mostly of water, and all the delicate tissues which cover and line the inner organs

of the body are kept soft and moist by it. They could not do their work without it.

Alcohol always takes up water wherever it finds it. Weigh a piece of lean meat, and then let it stand in alcohol for a few days. You will find, on taking it out and weighing it again, that it is lighter than it was. It has lost nothing but water, which was drawn out of it by the alcohol. It is drier, harder, and tougher than it was when you put it in.

Alcohol acts in much the same way when taken into the body. Even though diluted by water in the drink containing it, as in beer or wine or cider, and still further diluted by the fluids of the mouth and stomach, it yet has the power of drawing water from the tissues with which it comes in contact, leaving them inflamed and hardened.

It is the nature of alcohol, when taken even in small quantities, to **create an appetite** that demands more. This is the worst and most dangerous characteristic of this poison. At first the drinker intends to take only a moderate amount, ordinarily in the form of *beer*, *wine*, or *cider;* but the effects are so deceptive that he does not realize that the alcohol in these drinks is creating an appetite for more and still more. Alcohol also has the power of making the desire for it cling to its victim with great tenacity. Even after it has been overcome for years, this appetite may be easily awakened by the taste of a very small amount of any liquor containing it. Therefore wine, brandy, or other alcoholic liquors should never be used to flavor jellies, sauces, or any kind of food. While this appetite is not formed as

readily in some persons as in others, no one can be sure how soon alcohol will become his master if he takes it in any form.

Narcotics are substances which tend to deaden the action of the brain and nerves. They lessen the power to feel and think, and, if taken in large quantities, they cause unconsciousness and death. It is important for you to remember that **alcohol is a narcotic.** Every user of alcoholic liquors may not suffer from all the diseased conditions produced by alcohol; but all habitual drinkers sooner or later experience one or more of these conditions.

The ferments that are often found resting upon the skin and stem of the grape, soon change the sugar of the grape-juice to carbonic acid gas and alcohol. **Wine** usually contains about one tenth alcohol.

The idea that the drinking of wine will prevent the use of the stronger liquors, and will therefore be followed by less intemperance, is not based on truth. It is the nature of alcohol, even in such small quantities as are found in the lighter wines, to create an appetite not only for more wine, but for liquors that contain more alcohol. In France, a grape-growing country, where much more light wine is drunk than in this country, statistics show that the same amount of stronger liquors is used, in proportion to the population, as in the United States. The use of the lighter wines tends to the formation of the alcoholic appetite rather than to the prevention of drunkenness.

There is ordinarily as much alcohol in *home-made wines* produced from domestic fruits, as in those manufactured on a larger scale. Often there is more,

as the housewife is apt to add sugar to the fruit juice. Such wines are by no means safe drinks.

You remember that fermentation changes the nature of whatever it works upon. Vinous fermentation changes the sugar in fruit and plant juices into alcohol and carbonic acid gas. It thus turns a food to a poison. If such fermented liquors as wine or cider remain open long enough exposed to warm air, another ferment will enter and turn their alcohol into an acid. What was before wine or cider is now called vinegar. There is no alcohol in vinegar. The process that produced this change is called **acetic fermentation.** The alcohol is changed into an acid, called acetic acid or vinegar. This kind of fermentation changes a poison to a substance safely used to flavor food.

Barley and other grains are composed mostly of starch. To make **beer,** the grain is moistened and kept warm until it begins to sprout. The sprouting turns most of the starch into sugar. Enough heat is then applied to stop the sprouting. Grain after it has been thus treated is called *malt.* This malt is mashed or ground, and the sugar soaked out with water. As the same ferments referred to in cider and wine will not work as quickly in this fluid, *yeast,* which is one kind of ferment, is then put in, with *hops* to give it a bitter taste, and the whole is kept warm.

The ferments of the yeast begin at once to act upon the sugar of the barley juice, converting it into carbonic acid gas, which escapes, and into alcohol, which remains in the beer. The barley was a healthful grain; but the beer made from it is another in-

stance in which vinous fermentation has changed a food to a poison.

Beer often causes serious diseases of the liver and kidneys, even when only a little is taken at a time. It puts the whole body in such a condition that trifling wounds or slight attacks of cold or malaria often end fatally. Of the whole group of alcoholic drinks, beer is said to have the worst effect upon the moral nature, making the drinker selfish and brutal.

That workmen must have beer to quench their thirst, is a false idea. Besides being poisonous because of the presence of alcohol, beer creates thirst. A wholesome and refreshing drink, much used in furnaces and foundries, is made from oatmeal and water.

If the weaker liquors, such as *beer*, *wine*, and *cider*, are heated in a close vessel to a point just below boiling, the alcohol will turn to a vapor and pass off, leaving much of the water behind in the boiler. By passing this vapor through a cool coil of pipe, it will be turned to a liquid again, and will drip into another vessel at the end of the pipe. This process is called **distillation.** This second liquid will have nearly all the alcohol of the first, with less water, so that it is very strong. *Brandy* is distilled in this way from wine. *Whisky*, *rum*, and *gin* are distilled liquors.

Distilled liquors are about one half alcohol. Before distilling came into practice, the strongest drinks that could be produced by fermentation were about seventeen parts alcohol in one hundred of water. The evil consequences of the use of fer-

mented drinks have been greatly increased by the use of distilled liquors. Fermented drinks are often made stronger by putting in more alcohol to satisfy the increasing appetite.

From the unripe seed-vessels of the white poppy is extracted a thick juice called **opium.** When dried, it forms a gum that may be smoked or chewed like tobacco. The effect of opium is that of a narcotic poison, producing giddiness, drowsiness, and stupor, which ends in death if a sufficient quantity is taken. Its continued use in small quantities leads to weakness of the muscles, failure of the nervous system and of the digestive organs, to such an extent that the person sometimes dies of starvation. Opium, and other drugs prepared from it, are often given by doctors to relieve pain and cause sleep.

Like alcohol, opium creates a craving for itself that often proves irresistible. Persons who once form the habit of taking opium rarely quit its use. It weakens and degrades the mind, ruins the health, and in sufficient quantities will destroy life.

Opium owes its poisonous properties largely to the presence of a powerful narcotic substance called morphia, commonly known as *morphine.* Chemists find from ten to thirteen parts of morphia in a hundred parts of opium. Its effects are the same as those of opium, except that it does not so soon attack the digestive organs. The morphine habit, once formed, is one of the most difficult of all narcotic habits to break, and quickly ruins its victims.

Patent medicines largely advertised as "soothing sirups" to cause sleep in infants, are often made

from poppies or other substances having narcotic properties. A few doses of some of these have been known to cause the death of young children. No medicine should ever be used to produce sleep in infants, except by the advice of a doctor.

Summary for Review.

1. *What is usually done with fruit juices after they are pressed out?*
   They are left exposed to the warm open air.
2. *What then happens?*
   A change takes place in the juice that entirely alters its nature, producing in it a poison called alcohol.
3. *What turns good fruit juices to poisons?*
   Something called a ferment, that floats in the air, and is sometimes found resting on the skins or stems of fruit.
4. *From what do fruits and plants get their sweet taste?*
   From the sugar that forms a part of their juice.
5. *On what part of fruit and plant juices do the ferments act?*
   Upon the sugar.
6. *Into what is the sugar changed by the ferments?*
   It is changed into carbonic acid gas and alcohol.
7. *What name is given to the work done by the ferments?*
   Fermentation.
8. *What is vinous fermentation?*
   The change of the sugar in a fermentable liquid into alcohol and carbonic acid gas.

9. *What conditions are necessary to produce vinous fermentation?*
   Sugar, water, heat, a ferment, and air, all in the right proportions.
10. *What is the important fact to remember about fermentation?*
   That it entirely changes the nature of any substance upon which it acts.
11. *Why are fermented liquors poisonous, while bread raised by fermentation is not?*
   Because alcohol remains in the fermented liquors, but does not remain in the bread.
12. *What does alcohol look like?*
   It looks like water.
13. *How does it differ from water?*
   It will burn with a blue flame; it will dissolve resins and other substances which water will not; and it is a poison.
14. *What is true of the nature of alcohol?*
   It is the nature of alcohol to injure health by its action on the body, and to destroy character by its action on the brain.
15. *For what has alcohol a great affinity?*
   For water. It will mix with water wherever the two chance to meet.
16. *How much of the body is water?*
   About seven eighths of the body, by weight, is water.
17. *What is one important use of this water?*
   It keeps the delicate tissues of the body soft and moist.
18. *How does alcohol interfere with this?*
   It extracts water from these tissues, leaving them shriveled, hardened, or inflamed.

19. *What is the most dangerous characteristic of alcohol?*
It creates an uncontrollable thirst for itself.
20. *What is a narcotic?*
Any substance which, when taken into the blood, tends to deaden the action of the brain and nerves.
21. *Why is alcohol classed as a narcotic?*
Because it has this effect on brain and nerves.
22. *From what is wine made?*
From the juice of grapes.
23. *How much alcohol does wine contain?*
Usually about one tenth.
24. *What false idea has been held regarding wine drinking?*
That it prevents the use of stronger alcoholic liquors.
25. *Does it do this?*
Facts show that it does not.
26. *What is true of home-made wines?*
They usually contain as much alcohol as other wines, and often more.
27. *What takes place when wine or cider is left open to warm air?*
A second ferment enters and changes the alcohol to acetic acid.
28. *What is the result of this?*
The wine or cider becomes vinegar.
29. *What is this change called?*
Acetic fermentation.
30. *What is beer?*
An alcoholic drink made from barley or other grains.
31. *Of what are grains mostly composed?*
Of dry starch.
32. *How may the starch of such grains be turned to alcohol?*
It must first be changed to sugar, and this is done by moistening the grain and keeping it warm.

33. *When the starch of the grain has been turned to sugar, what must be added to produce vinous fermentation?*
Water and yeast.

34. *Is there any food value in beer?*
There is none to speak of. The food properties of the barley juice are nearly all destroyed by the processes of fermentation.

35. *What diseases is beer liable to produce?*
Diseases of the liver and kidneys.

36. *Why is the use of beer unwise?*
Because it creates thirst.

37. *How much alcohol is found in the strongest liquors that can be made by vinous fermentation?*
About seventeen parts of alcohol in one hundred parts of the whole fluid.

38. *How are liquors containing more alcohol obtained?*
By a process called distillation.

39. *Describe it.*
A fermented liquor is heated to a little below the boiling point, in a vessel with a pipe attached to a close-fitting cover. Just before the water boils, the alcohol will turn to a vapor, pass through the pipe, which is kept cool, and drip into a vessel at the other end.

40. *What is the fluid thus formed?*
It is a liquor very rich in alcohol, called a distilled liquor.

41. *What are some of the distilled liquors?*
Rum, gin, brandy, and whisky.

42. *How much alcohol do they contain?*
They are about one half alcohol.

43. *What has been the effect of the discovery of distillation?*
The evils of intemperance have been greatly increased.

44. *What is opium?*
A gum taken from the seed-vessels of poppies.
45. *What is the nature of opium?*
It is a narcotic poison.
46. *What are some of its effects upon the nervous system?*
It deadens the nerves and brain, causing stupor that ends in death when a sufficient quantity is taken.
47. *What is true of its continued use in small quantities?*
It will weaken and degrade the mind, ruin the health, and shorten life.
48. *What is morphine?*
A narcotic poison that is extracted from opium, and possesses its dangerous characteristics.

CHAPTER VII.

DIGESTION.

Definitions.

bī ĕŭs′pid, two-pointed.
eŭs′pid, having one point.
dĕn′tĭne, the bony part of the teeth, lying just beneath the enamel.
e sŏph′a ḡŭs, the food-pipe, or gullet.
ḡăs′trĭc, belonging to the stomach.
in çī′s̲or̲s̲, the cutting teeth in the fore part of the jaws.
mō′lar̲s̲, the grinding teeth in the back part of the jaws.
sa lī′va, the juices of the mouth.

Our bodies are constantly wearing out. Every motion we make, everything we do, is caused by the waste of some portion of the body. These wasted parts must be renewed. The new material to repair them comes from our food.

Food must be greatly changed from the form in which we eat it before it is ready to aid in growth and repair. It must be ground into fine particles, turned into liquid form, and be separated, so that what is good can be used for nourishment, and what is unfit can be rejected.

These changes in food are called **digestion.** The parts which perform this work are called the organs of digestion; they are the *mouth*, *stomach*, *liver*, *pancreas*, and *intestines.*

The teeth are used for cutting and grinding the

food. We have two sets of teeth: (1) the temporary set, and (2) the permanent set.

The first or *temporary set* lasts us only during childhood. There are twenty teeth in this set, ten in each jaw.

The second, or *permanent set*, grows in the jaws

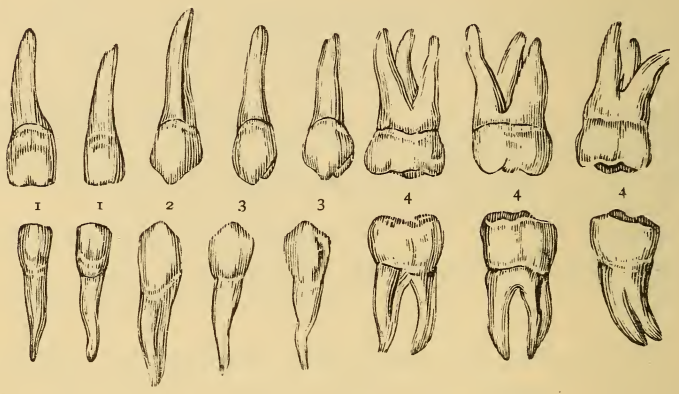

Fig. 22.

THE TEETH OF THE LEFT SIDE.

1, incisors; 2, cuspids; 3, bicuspids; 4, molars.

beneath the first set, and, by increasing in size, causes the temporary teeth to loosen and come out. The second set consists of thirty-two teeth, sixteen in each jaw. The front eight, four above and four below, are flat and sharp, and are called *incisors* or cutting teeth. The next four, two in each jaw, have one point, and are called *cuspids* or eye-teeth. The next eight, four in each jaw, have two points, and are called *bicuspids*. The hindmost twelve, six in each jaw, are broad and rough, for grinding the food, and are called *molars*. The last four molars

are called wisdom teeth, and do not appear until maturity. (See Fig. 22.)

Each tooth has two external parts: the *root*, and the *crown*. The root is imbedded in the jaw-bone, and holds the tooth firmly in place. The crown is the portion we see.

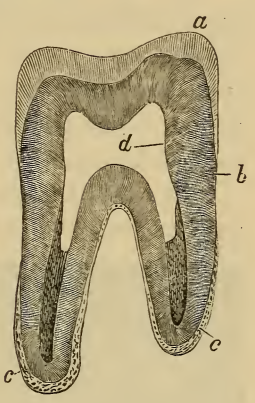

Fig. 23.

SECTION OF A MOLAR.

a, enamel; *b*, dentine; *c*, passages for nerves and blood-vessels; *d*, cavity for the same.

The crown is covered with a thin shell of very hard substance called *enamel*. (See Fig. 23.) This is the white, glistening part, and protects the crown from wear and decay. Though the enamel is very hard, it may be cracked by very hot or very cold food or drink, or by biting sharply on hard bodies like nuts. If the enamel is once cracked or broken it can not be renewed, and the inner part of the tooth tends to decay.

The main body of the tooth is made of *dentine*, a substance that is harder than bone. Inside of the dentine there is a soft, pulpy portion containing the nerves and blood-vessels of the tooth. (See Fig. 23.)

Care of the Teeth.—We should brush the teeth once or twice daily, using a soft brush and water. They should be white, and be smooth to the tongue and lips. If brushing will not cleanse them, we may use powdered chalk on the brush. We should use tooth-picks of wood or quill, and remove the particles of food from between the teeth after eating. It is

quite as important to pick the teeth well as to brush them.

If the teeth begin to decay, we should at once have a dentist cut away the decaying portion, and fill the cavity. We need to watch the teeth closely, for, even while we are children, they often begin to decay. By proper care we may keep them in a reasonably good condition through life.

The mouth is kept moist by a watery fluid, called **saliva,** that is constantly flowing into it. When we are chewing, the saliva flows fast to moisten the food and make it easy to swallow. The saliva contains a substance that aids in changing the starch of the food to sugar. This is why bread becomes sweeter by chewing it and holding it in the mouth.

Fig. 24.

One of the Salivary Glands.

The saliva is supplied by six glands, three on each side, called *salivary glands*, that take materials from the blood, to make the saliva, and pour it into the mouth. These glands are under the muscles of the tongue and jaw, so that in chewing, the muscles press on the glands and make them work more rapidly. They are bunches of tiny, thin sacks. (See Fig. 24.) Two of these glands are just in front of the ears; two others are under the lower jaw; another pair is under the tongue.

When we have chewed the food, we press it far back in the mouth with the tongue, and swallow it. In swallowing, the food passes through a muscular tube called the *esophagus*, which leads from the mouth to the stomach.

We should chew food well, in order that it may be swallowed easily, and be in good condition for the stomach to use. We should not eat hastily, nor drink while we are swallowing food.

The stomach is a soft, fleshy bag into which our food and drink go when they are swallowed. It is in the abdomen, just above the central part of the trunk. It is pear-shaped, and will hold a quart or more. It has two openings, one for admitting food, the other for passing it onward. (See Fig. 25.) These openings are held somewhat firmly closed by rings of muscle, so that food can not readily return into the esophagus, nor escape into the intestines until the stomach has finished its work. The first opening is called the *cardiac*, because it is near the heart; the second is known as the *pylorus*, a word which means "gate-keeper."

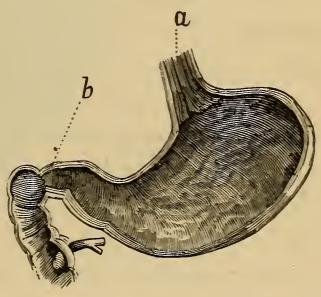

Fig. 25.

SECTION OF STOMACH.

a, cardiac opening; *b*, pylorus.

The stomach is formed of three coats: the inner coat is a membrane like the lining of the mouth; the middle coat is made of muscle; the outer coat is moist and smooth.

When we swallow our food, the stomach is aroused from rest and begins its part of the work of digestion. The muscles move the food about with a churning motion, more blood flows to the stomach to aid in warming the food, and many tiny glands pour their *gastric juice* into the stomach to assist in dissolving the food.

The gastric juice is taken from the blood by a great number of small glands located in the inner coat of the stomach. This juice is chiefly water, but contains a small quantity of acid and a peculiar substance called *pepsin*. The stomach is most effective in digesting the albuminoid foods, but at the same time it warms and softens the other kinds for complete change in the intestines. The warm juices and the motion mix the food, make it soft, and change it so completely from its original condition that it becomes a gray fluid, called *chyme*.

Some of the more easily digested food passes directly through the lining of the stomach into the blood-vessels, but the greater part passes slowly into the intestines for further digestion. After two or three hours' work the stomach's task is done, and, having emptied itself, it should rest until the following meal.

The intestines receive the partially digested food as it passes out of the stomach. (See Fig. 26.) The small portion of the intestines is joined to the stomach at the pylorus. It is a tube about an inch in diameter, and twenty feet in length. This long, soft tube lies in folds in the middle of the abdomen. It leads into a much larger but shorter tube known

as the large intestine, or *colon*, which is folded around the smaller.

The food is moved slowly along the intestines, and is mixed with a fluid from the **liver** and with

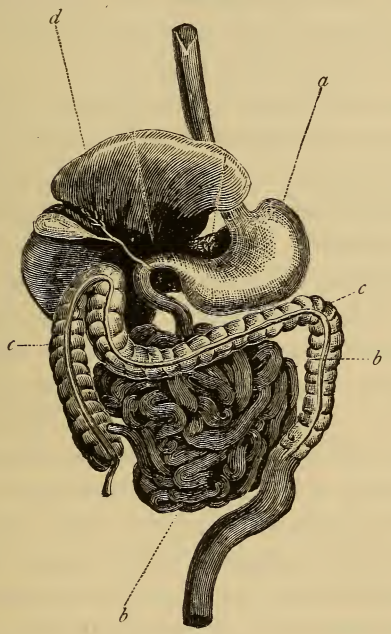

Fig. 26.

STOMACH, LIVER, AND INTESTINES.

a, stomach ; *b*, small intestine ; *c*, large intestine ; *d*, liver.

juice from the **pancreas.** The liver is a large gland to the right of the stomach (Fig. 26), and is connected both with the digestion of food and the circulation of blood. It pours a bitter, copper-colored substance called bile into the intestines. The pancreas is a smaller gland back of the stomach,

and pours a fluid somewhat like saliva into the intestines. These two fluids are not acid, as the gastric juice is, but are suited for digesting fat, sugar, and starch. The food remains several hours in the intestines, and has ample time for complete digestion. The portion that is to nourish the body is changed into a milky fluid called *chyle*.

As the useful part of the food is made ready for nourishment, it is drawn from the intestines into the blood, and is hurried away to all parts of the body to aid in growth and repair. The taking of the food from the stomach and intestines into the blood is called *absorption*. The undigested food passes into the colon, and is finally cast out of the body.

The Health of the Digestive Organs.—We should try to keep the digestive organs in healthy condition, for we are nourished by the food which they digest. Weakness or disease of these organs will surely destroy our health and strength. Whatever enriches the blood will improve the action of these organs. Proper exercise makes more demand for nourishment, and strengthens the digestive organs.

It is estimated that a healthy man in a temperate climate needs about two pounds and a half of solid food, and about three pints of drink, each day. This is the smallest quantity that will serve him well. Hard labor and exposure increase the amount needed. Men usually eat more than this quantity. If we eat too often, the stomach does not have proper intervals of rest. Eating between meals disturbs the stomach.

When **tobacco** is chewed, some of its poison goes directly into the blood through the lining membrane

of the mouth, and is then carried in the circulation to every part of the body. Besides this, some of the poison of the tobacco is swallowed. In these two ways the tobacco reaches the stomach and weakens and interferes with its important work. So great is the harm done that those who use tobacco usually suffer from poor digestion.

Alcoholic drinks greatly hinder the work of the stomach. They cause the substance called pepsin, which is an important part of the gastric juice, to sink to the bottom instead of remaining dissolved as it ought in the digestive fluid. The gastric juice, thus deprived of its pepsin, loses its power to dissolve the food, which therefore has to lie in the stomach until the glands can pour in enough new juice to dissolve it. This extra work in time exhausts the glands, and leads to dyspepsia.

Dr. Monroe, of the Hull Medical School, England, mixed pieces of bread and meat in a vial with some gastric juice. He then corked the vial and set it in a little box of heated sand, where it was kept about as warm as it would be in a healthy stomach. Occasionally he shook the box to imitate the motion of the stomach. He prepared another vial in the same way, only that he added ale. In the first vial the food was dissolved inside of ten hours, but in the vial containing the ale it did not dissolve, though he kept it warm for several days.

Alcohol, by extracting moisture from the mucous membrane that lines the stomach, irritates it, causing congestion and inflammation, according to the amount taken. The natural appetite which comes

from exercise and fresh air shows how much food can be made into blood for the body's present needs.

When the stomach is often irritated by small quantities of alcohol, such as a glass of ale at breakfast, another during the forenoon, a glass of wine at dinner, perhaps, and so on through the day, the mucous membrane becomes inflamed, and remains so. Ulcers form, and catarrh of the stomach pollutes all the food taken into it. Strange to say, one's stomach may be in this condition without causing any severe suffering. There will be little appetite for food, however, and a continual craving for more of the same alcohol that has made all the trouble.

Alcohol greatly injures the liver. It slowly filters through all the delicate tissues of this organ, sometimes causing them to shrink and harden. A liver in this condition is said to be "hob-nailed." Sometimes an excessive growth of fat and of connective tissue is produced by the alcohol, and the liver becomes enormous in size. But the fat and tissue do not perform the work of the true liver substance which is crowded by them. A liver in either of these conditions can not properly make bile, and food is therefore imperfectly digested. The liver can not separate substances from the blood which ought not to be in it, and the blood becomes overloaded with impurities. The consequences are dropsy, gout, and various other diseases.

Recent investigations have shown that even in small quantities, alcohol, if taken frequently, is almost sure to injure the heart, liver, or kidneys; and sometimes all of them.

Summary for Review.

1. *How is bodily waste repaired?*
   By new matter from our food and drink.
2. *How must food be changed?*
   From its natural form to a milk-like fluid that can enter the blood.
3. *What two parts of the food must be separated?*
   The useful portion from the unfit part.
4. *What is this change in food called?*
   Digestion.
5. *What organs digest the food?*
   The mouth, the stomach, the liver, the pancreas, and the intestines.
6. *What is the digestive use of the teeth?*
   To chew the food.
7. *What sets of teeth do we have?*
   Temporary and permanent.
8. *What is the temporary set?*
   Those that last only during childhood, twenty in number.
9. *What is the permanent set?*
   The teeth that come later in life to serve as long as we live, thirty-two in the set.
10. *What are the roots for?*
    To hold the tooth in place.
11. *What is the crown for?*
    To chew the food.
12. *What is the enamel?*
    The hard, outer portion of the crown.
13. *What is the dentine?*
    The hard substance that forms the body of the tooth.
14. *What is the pulp?*
    The softer portion which contains the nerves and blood-vessels.

15. *What is saliva?*
The watery fluid that moistens the mouth and the food.
16. *Where are the salivary glands?*
Beneath the tongue and inside the jaw.
17. *What is the esophagus?*
The muscular tube leading from the mouth to the stomach, through which we swallow food and drink.
18. *Why should we chew food well?*
To make it easy to swallow, and to prepare it for the stomach.
19. *Why should we not chew tobacco?*
It exhausts the salivary glands, stains the teeth, and gives the breath a bad odor.
20. *What is the stomach?*
A fleshy bag for receiving and digesting food.
21. *Of what is it formed?*
Of three coats: an inner coat of mucous membrane, a middle muscular coat, and an outside coat which is moist and smooth.
22. *What does the stomach do to the food?*
It moves the food about, and mixes it with juices until the food is changed to chyme.
23. *What becomes of the food?*
Part of it is taken into the blood, but the greater portion passes into the intestines.
24. *What are the intestines?*
The long, soft tube that receives food from the stomach for complete digestion.
25. *What do the intestines do to the food?*
They move the food slowly, and mix it with other juices that turn the useful portion into a milky fluid called chyle.

26. *What is the liver?*
It is a large gland, to the right of the stomach. It pours out a digestive fluid called bile.

27. *What is the pancreas?*
It is a smaller gland, and is back of the stomach. It pours out a digestive fluid somewhat like saliva.

28. *When tobacco is taken into the mouth, where is some of the poison carried?*
Directly into the blood, through the lining membrane of the mouth.

29. *Where does more of it go?*
Into the stomach, some of the poison being swallowed, even by the most cautious.

30. *How does tobacco affect the stomach?*
It weakens it and interferes with its important work.

31. *What effect has alcohol upon digestion?*
It greatly hinders the process of digestion.

32. *In what way does it do this?*
By separating the pepsin from the gastric juice.

33. *How does this hinder digestion?*
The gastric juice, when deprived of its pepsin, loses its power of dissolving food.

34. *What does this produce?*
Dyspepsia.

35. *What further harm does alcohol cause in the stomach?*
It irritates and inflames the mucous membrane that lines the stomach.

36. *What effect in the stomach follows the use of a very small quantity of alcohol?*
A small quantity of alcohol, as in a glass of cider or beer, will produce a slight irritation of the stomach.

37. *Why does the drinker feel so little discomfort from this irritation?*

Partly because the stomach has few nerves of feeling, and partly because those nerves are so deadened by alcohol that their action is impaired.

38. *What proportion of alcohol taken into the stomach reaches the liver?*

Almost every drop of alcohol taken into the stomach is carried directly to the liver.

39. *What does it do there?*

It slowly filters through all the delicate tissues of the liver.

40. *What effect has this upon the liver?*

It may cause the liver to become greatly enlarged and loaded with fat, or to shrink into a rough, hardened mass called hob-nailed liver.

41. *What is the result of this?*

A liver in either of these conditions can not do its work properly.

42. *To what will this lead?*

To impurity of the blood, giving rise to various diseases.

The Arterial System.

CHAPTER VIII.

THE WORK THE HEART DOES.

Definitions.

au'ri cles, the two ear-shaped upper chambers of the heart.

cap'il la ries, the minute blood-vessels which connect the arteries with the veins.

cor'pus cles, tiny bodies which float in the blood.

fi'brin, a white, albuminous, fibrous substance, formed in the coagulation of the blood.

mi nute', very small, tiny.

ven'tri cles, the two stomach-shaped lower chambers of the heart.

The blood, as it flows through our bodies, bears to every part new material received from the stomach and intestines. Each part takes from the passing blood whatever it needs for *growth and repair*. No part could live unless the blood nourished it in this manner.

The blood does another great service by gathering into itself the *waste* materials from these parts and carrying these impurities away to be cast out of the body. No part could live if these poisonous impurities were not taken away. The blood is the sweeper and cleaner, as well as the feeder, of the living body.

The blood also carries in its current the materials that give *warmth* to every part. Any part of the body in which the blood did not flow would become cold and die.

From these uses, we see that the blood is the life of the body; it nourishes, cleanses, and warms the whole.

How the Blood Circulates.—The heart is the center of the circulation. It sends the blood with great force into tubes, called *arteries*, that lead away from the heart. The arteries divide into smaller and smaller branches, until they become so minute that they can not be seen. The smallest tubes are called *capillaries*. They distribute the blood to every portion of the body.

The blood makes its way slowly through the capillaries, and begins to flow into other and larger tubes, called *veins*, that convey it back toward the heart. These veins flow into others as do the branches of a river, until finally they pour the blood back into the heart.

The impure blood that the veins bring back to the heart is at once sent through the lungs to be purified, and is returned to the heart a second time before it is ready to be hurried away again to the various parts of the body.

In this wonderful manner the blood is at all times rushing away from the heart in rapid streams, bearing its life-giving properties to every needed place, then flowing back in constant streams to the heart, and thence with its load of impurities to the lungs. Thus it continues every moment of our life, never stopping in its flowing, never resting in its work.

Nature and Uses of the Blood.—Blood is heavier and thicker than water. It is composed of two parts: (1) a watery portion, called *plasma;* and (2)

a vast number of very small, rounded particles, called *corpuscles*. Some of these are colorless, but most of them are a yellowish red. (See Fig. 27.) The red corpuscles are so numerous that they make the whole liquid of the blood, or the plasma in which they float, look red. The red corpuscles have the power of absorbing gases, which they carry back and forth in the current of the blood. You will learn in the next chapter that one of the important gases that compose the air is called oxygen. Every part of the

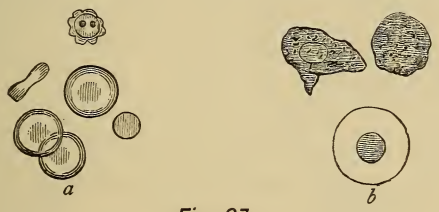

Fig. 27.

BLOOD CORPUSCLES.

a, colored; *b*, colorless.

body needs this oxygen, and suffers if deprived of its necessary amount. The red blood corpuscles are oxygen-carriers. In the lungs, they fill out with oxygen, which they give up wherever it is needed through the body.

As food and the oxygen of the air are turned into the bones, nerves, muscles, etc., that compose the body, there is more or less waste matter thrown off. Carbonic acid gas is one of the chief waste substances thus made by the body, and it must be removed. The red corpuscles absorb this gas, and as they return by way of the veins, carry it to the lungs, where it passes out in the breath.

The blood also contains certain substances that cause it to thicken or clot when it comes in contact with the air. It is this thickening of the blood around the edges of a cut or wound that stops the bleeding.

The Organs of Circulation.—The heart pumps the blood through the body. It is placed near the center of the chest. We can feel its beating by putting the fingers lightly a little to the left of the front of the chest, and we can hear it at its work by placing the ear against the chest of another. By keeping count, we shall find that it beats about seventy-two times in a minute. The heart of a child beats faster than that of a grown person. The heart beats more rapidly during exercise than when we are quiet. The doctor learns how fast the heart beats by feeling the pulse at the wrist, and he ascertains whether the heart is in good health by listening to its sounds in the chest.

The heart is made of strong muscle, because it is a hard worker. It is about as large as the fist, and is shaped like a top or a pear, the point being downward and forward. It is hung in the chest, and is inclosed in a smooth cover that permits it to move with very little rubbing or friction.

The heart is double, having its right and left sides separated by a thick wall of muscle. (See Figs. 28 and 29.) Each side has two rooms, one over the other, making four in all. The two rooms on the right side are called the *right auricle* and *right ventricle;* the two on the left side are the *left auricle* and *left ventricle.* The auricles are above the ventricles, and

open downward into the ventricles by door-like valves, that permit the blood to pass down from the auricles into the ventricles, but not to return.

The auricles have thin walls, and receive the blood from the veins as it flows back to the heart. The ventricles are very strong, with thick walls for forcing the blood out of the heart. The right ventricle sends

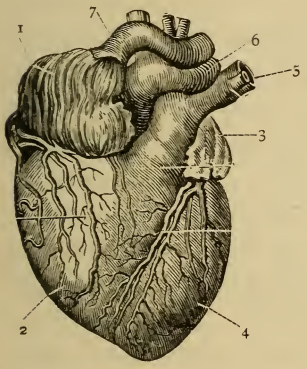

Fig. 28.

FRONT VIEW OF THE HEART.

1, right auricle; 2, right ventricle; 3, left auricle; 4, left ventricle; 5, artery to the lungs; 6, artery to the body; 7, vein from body.

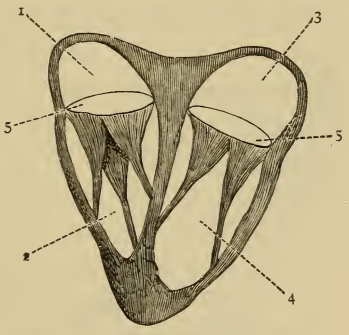

Fig. 29.

DIAGRAM SHOWING CHAMBERS AND PASSAGES OF HEART.

1, right auricle; 2, right ventricle; 3, left auricle; 4, left ventricle; 5, valves between auricles and ventricles.

the blood to the lungs; the left ventricle is very powerful, and forces the blood into the large arteries that convey it to all parts of the body.

The heart is a hard worker, yet it has brief intervals of rest. The contraction of the ventricles is the work; the relaxation is the rest. The time of contraction is nearly twice as long as that of relaxation. These short periods of rest, taken together, amount to more than eight hours of the twenty-four. All

the blood in the body—nearly two gallons—passes through the heart in less than three minutes.

It is the contractions of the strong ventricles that cause the heart to beat. They close upon the blood with such force that the heart rebounds and strikes the chest. After contracting they relax, to be filled again from the auricles. If they were to stop we should die.

The arteries conduct the blood from the heart. They are strong, white, elastic tubes. The great artery which leads out of the left ventricle is called the *aorta;* it receives all the pure blood, and by its branches distributes it to every part of the body. The blood in the arteries is bright red, and flows rapidly. If an artery is cut, the blood will flow out in jets. For protection, the arteries are placed deep in the flesh and close to the bones.

The capillaries are extremely small tubes, which receive the blood from the arteries, and which form a thick network of hair-like passages in all parts of the body. (Fig. 30.) The blood flows more slowly in the capillaries, so that it may have time to do its work.

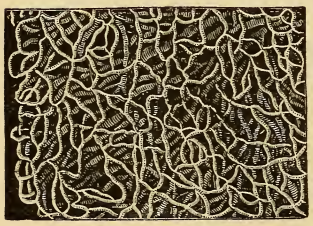

Fig. 30.

CAPILLARIES OF THE CIRCULATION. MAGNIFIED.

The veins receive the impure blood from the capillaries. They are larger than the arteries, more crooked, and nearer the surface. The blood in the veins is darker than that in the arteries, and flows steadily toward the heart. The veins have valves in them

which permit the blood to flow only toward the heart. Our muscles press on the veins when we move, and help to force the blood onward. The large veins pour the impure blood into the right auricle of the heart.

Hygiene of the Circulation.—Clothing that binds closely presses on the blood-vessels, and prevents the proper flow of the blood. We should, for this reason, avoid shoes that are closely laced about the ankles, and clothing that compresses the waist.

Exercise improves the circulation, but too violent exertion may injure it by making the heart work too hard or by causing bleeding of the nose or lungs. If wounds bleed very freely, the blood may be stopped by pressing on the wound, or by wrapping a close bandage around it.

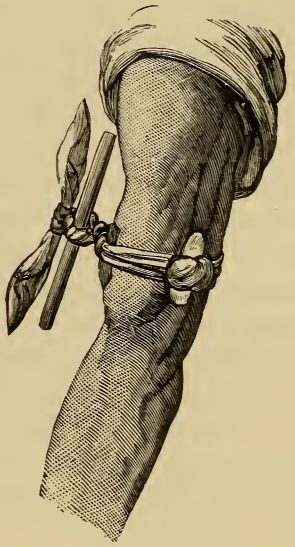

Fig. 31.
COMPRESSION OF ARTERY OF ARM.

When a large artery is cut, there is danger of bleeding to death. In such cases a strong cord may be tied between the cut and the heart, and be twisted so as to press firmly on the artery, and prevent loss of blood until a surgeon comes.

Fig. 31 shows how the bandage should be wound round the arm to stop the bleeding when the hand or fore-arm is badly cut. Observe that a knot is

tied in the cord, handkerchief, or whatever is used, and that this knot is so placed as to press on the large artery of the arm. The cord is placed above the elbow because there is but one bone between the elbow and the shoulder. If the foot or leg were cut, the cord should be placed above the knee, with the knot pressing behind or beneath.

We can learn the positions of some of the large arteries by pressing on them and feeling the blood as it passes through them in pulses. If we learn where the arteries are, we shall know better how to stop the bleeding in case of a dangerous wound.

How Alcohol injures the Circulation.—Alcoholic drinks put the blood of the drinker in a bad condition. It does not thicken as it should around the edges of a wound. Surgeons are unwilling to perform operations on habitual drinkers, because their wounds will not stop bleeding or heal like those of a total abstainer.

When alcohol is present in sufficient quantities in the blood, it shrivels up the red corpuscles by extracting water from them. They can not therefore carry so much oxygen from the lungs to the tissues, nor bring back so much carbonic acid gas. The blood becomes loaded with fatty and other waste matters.

Sometimes alcohol causes the corpuscles to run together in little masses which block up the passages in the minute blood-vessels, and thus obstruct the circulation. When a very large quantity of alcohol is taken, it may cause what is called the fibrin of the blood to coagulate, and this also blocks

up the passages. If this occurs in the brain it causes paralysis; if in the liver or kidneys, cutting off the supply of blood, it results in fatal diseases.

On the other hand, alcohol often weakens the walls of the blood tubes, so that these passages become larger. The capillaries, which in their healthy condition are invisible, become so enlarged and filled with blood that they can be seen in the flushed face and bleared eye of the drinker. This is because the nerves which control these blood-vessels become relaxed by the paralyzing effect of alcohol, and let in more blood than they should.

The heart is a great muscle, and alcohol acts on it as it does on other muscles, causing an overgrowth of fat. It can not then throw the blood out with the right amount of force. Alcohol also weakens it in another way. You learned that to make your muscles strong they must have rest. The heart takes its rest between every beat. But when alcohol is taken, the time between each beat is shortened; consequently, it has less time to rest and becomes overworked.

Serious diseases of the heart are also caused by the use of **tobacco.** One form is called by the physicians, "tobacco-heart."

Summary for Review.

1. *What are the uses of the blood?*
   It nourishes, cleans, and warms all parts.
2. *What is the center of circulation?*
   The heart.

3. *How does the blood flow constantly?*
   In two sets of streams, one set leading the blood from the heart to all parts, and the other returning the blood to the heart.
4. *How is the blood described?*
   It is a red liquid, heavier and thicker than water.
5. *Of what two parts is it composed?*
   Plasma and corpuscles.
6. *What is the plasma?*
   The colorless liquid part.
7. *What are the corpuscles?*
   Tiny red bodies that color the blood.
8. *What is the work of the red corpuscles?*
   To carry oxygen to the tissues from the lungs, and to carry out carbonic acid gas.
9. *What is one important quality of the blood?*
   Its power of thickening or clotting around the edges of a wound to stop bleeding.
10. *What is the heart?*
    The central organ that circulates the blood.
11. *What is its size?*
    It is as large as the fist.
12. *How fast does it beat?*
    About seventy-two times a minute; but faster when we are exercising than when at rest.
13. *How is the heart constructed?*
    Of a hollow mass of muscles. It has two separate sides, and each side contains two rooms.
14. *What are the auricles?*
    The upper rooms of the heart, for receiving the blood as it returns to the heart.
15. *What are the ventricles?*
    The lower rooms of the heart, for forcing the blood out of the heart.

16. *How does the heart force the blood away?*
The ventricles contract with great force, and send the blood into the arteries.
17. *What are arteries?*
Blood tubes leading from the heart.
18. *What are the capillaries?*
The tiny tubes that connect the arteries with the veins.
19. *What are veins?*
Blood tubes leading back to the heart.
20. *How may we stop bleeding from severe wounds?*
By pressure and bandages.
21. *How does alcohol affect the blood-vessels?*
It weakens their walls, causing them to distend and sometimes to burst. It is on account of this enlargement of the veins and capillaries that the cheeks, eyes, and nose of the habitual drinker are usually flushed.
22. *How does alcohol weaken the heart?*
By clogging it with fat, and causing it to beat too fast.
23. *How does tobacco affect the heart?*
It weakens the heart and often causes heart disease.

CHAPTER IX.

THE WORK THE LUNGS DO.

Definitions.

dī'a phrăgm, the large muscle between the chest and abdomen.

ep i glŏt'tis, the lid-like cartilage at the top of the larynx.

lăr'ynx, the organ of the voice.

pŭl'mo na ry, pertaining to the lungs.

sys tĕm'ic, pertaining to the whole body.

trā'che a, the windpipe.

Air, and Our Use of it.—We live at the bottom of a vast ocean of air. This air is a gas which we breathe into our lungs and out again continually. Men can live many days without food or water, but so great is the need for air that five minutes without breathing will cause death.

About one fifth of pure air is *oxygen.* It is this oxygen, as you have learned, that is taken up by the red corpuscles of the blood to warm and strengthen the body. The oxygen of the air unites with other substances when they burn.

We need to breathe for two very important reasons: (1) the air that we breathe into the lungs gives some of its oxygen to the blood; (2) the air that we breathe out of the lungs carries off some of the impurities from the blood. Thus the air enriches the blood and purifies it.

The Organs of Breathing.—**The lungs** are the

principal organs of breathing. They surround the heart, and together with it fill the chest. Notice how we enlarge the chest so that more air rushes in to fill the lungs, and how we press some of the air out again by making the chest smaller. Certain muscles raise the ribs and make the chest broader. A great muscle called the diaphragm, which forms the arched floor of the chest, is pulled down, and this makes the chest deeper. Air from the outside rushes in through the nose and mouth when the cavity of the chest is thus enlarged, and is forced out again when the chest walls contract. The air passes in and out about eighteen times every minute. Exercise makes us breathe rapidly; in rest and sleep the breathing is slower.

The lungs are composed chiefly of two sets of passages: (1) tubes for the blood, and (2) passages for the air.

The blood tubes of the lungs consist of *arteries* that bring *impure blood from* the heart, *capillaries* in which the blood is purified by the air, and *veins* which return *pure blood to* the heart.

Air reaches the lungs by going in through the nose and mouth and passing back to the trachea, or windpipe, which leads into the center of the chest.

The trachea is about an inch in diameter, and four or five inches long. It is an open tube formed of cartilage. At the top of the trachea is the *larynx*, in which the voice is made. (See Chapter XII.) A curious cartilage, called the *epiglottis*, is fastened to the back part of the tongue, and when we swallow, this shuts closely like a lid over the

larynx to prevent food from getting into the air-passages.

At its lower end, the trachea divides into branches called *bronchial tubes;* these subdivide, and finally end in clusters of tiny sacks called *air-cells*, which

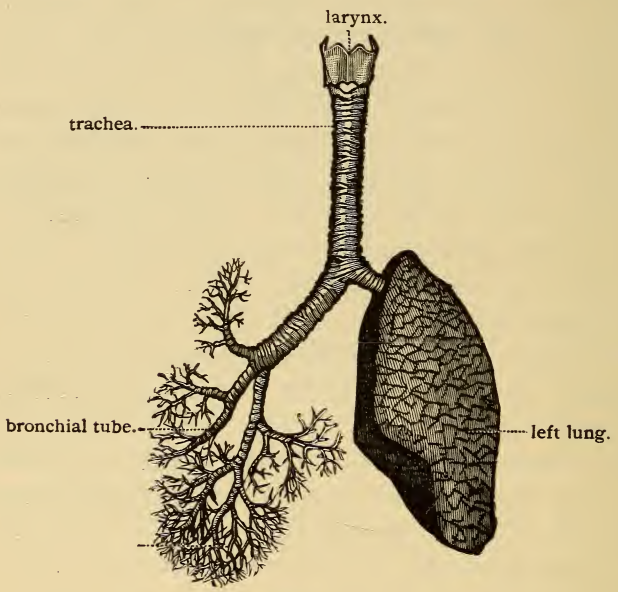

Fig. 32.

Diagram of Lungs and Air-tubes.

form the inner and closed ends of the air-passages. There are many millions of these air-cells in the lungs.

In Fig. 32 we see the larynx at the top, and the trachea leading downward and dividing into branches. The dark portion of the figure represents the left lung entire; on the opposite side, the substance of

the lung is removed to show how the bronchial tubes divide.

The air-cells receive the air that comes in through the tubes; they are extremely small, and have very thin and delicate walls. The lining of the air-passages is very sensitive, and becomes inflamed when we take cold. This most often affects only the throat; when it affects the larynx, we are hoarse and inclined to cough. If the soreness reaches the bronchial tubes, it is called bronchitis; if it is located in the air-cells and the parts that surround them, it is pneumonia; if it affects the lining membrane of the lungs, called the pleura, it is pleurisy.

How Air is changed in the Lungs.—The capillaries that hold the blood as it passes through the lungs cluster closely about the air-cells, so that the air within the cells and the blood within the capillaries are separated only by a partition much thinner than the finest of tissue paper. This partition is so very thin that the oxygen of the air readily passes through and enters the corpuscles of the blood, while the carbonic acid gas from the blood passes out and enters the air.

By these changes, the air we breathe into the lungs loses some of its oxygen and comes out loaded with impurities. Such air is unfit to be breathed again.

The changes in the blood as it goes through the lungs, are just the opposite. Carbonic acid gas leaves the blood and passes into the air, while oxygen from the air enters the blood. In these ways the impure, dark blood of the veins becomes the pure, bright blood of the arteries.

We can now see that there are **two parts to the circulation** of the blood. (Fig. 33.)

The impure blood passes from the right side of the heart through the lungs to be purified, and is returned as pure blood to the left side of the heart. This is called the *pulmonary circulation.*

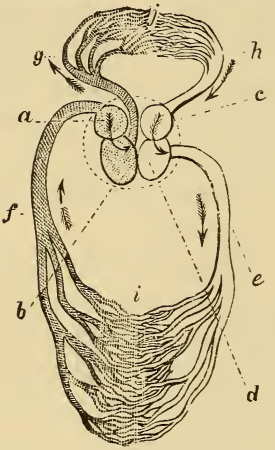

Fig. 33.

DIAGRAM OF THE CIRCULATION.

a, right auricle: *b*, right ventricle; *c*, left auricle; *d*, left ventricle; *e*, pure blood to the body; *f*, impure blood to the heart; *g*, impure blood to the lungs; *h*, pure blood to the heart; *i*, capillaries of the system; *j*, capillaries of the lungs.

The pure blood passes from the left side of the heart to all parts of the system, and returns as impure blood to the right side of the heart. This is called the *systemic circulation.*

The circulation of the blood may be traced as follows:

1. The blood enters the right auricle of the heart;
2. It passes into the right ventricle;
3. It is forced through the pulmonary artery to the lungs;
4. It circulates through the capillaries of the lungs to be purified;
5. It returns to the heart through pulmonary veins;
6. It enters the left auricle;
7. It passes into the left ventricle;
8. It is forced into the aorta and is distributed through the body;
9. It passes through the capillaries of the body and becomes impure;

10. It returns through the veins to the right auricle.

The normal **temperature of the body** is 98° Fahrenheit. So nicely is the warmth regulated that, in health, it remains the same at all times. Any change in the heat of the body, either above or below 98° Fahrenheit, indicates ill health.

The rooms in which we live should have openings through which the impure air can escape, and pure air can come in. This change of the air of rooms is called **ventilation.** For this reason we should not close them altogether at night, but should leave openings at the windows or doors for change of air. To keep a lamp burning in the bedroom at night adds to the impurity of the air. In the morning, the sleeping-rooms should be opened to the air and sunlight. Rooms that are damp, or that are dark during the day, are unfit for sleeping-rooms.

Churches, lecture-rooms, halls, and school-rooms need thorough ventilation, because otherwise when many persons are in them the air would soon become impure. We can not study, think, or listen well in close rooms; we have headache, and are dull and restless if we do not have fresh air. If windows or doors are opened, those within should not remain in a draught of air from outside. It is usually best in cold weather to raise the windows a few inches, and fit a board under the lower sash. Sick-rooms need to be well ventilated. Fresh air should be admitted gradually and constantly.

One of the most common and fatal of diseases is **consumption.** It affects all the vital organs, but

principally the lungs. Consumption appears to be generally caused by breathing bad air, or by compressing the chest so that the lungs do not have proper room. A severe cold may result in consumption. Children may inherit a tendency to consumption from their parents. In such cases the greatest care is necessary in order to avoid the disease.

Medicine can do but little to prevent or cure consumption. Pure, dry air, outdoor life, and freedom from exposure to storm and sudden changes of temperature are needed.

Nicotine, the poisonous part of **tobacco,** tends to deaden the nerves and weaken the muscles. By weakening the muscles that perform the act of breathing, it lessens the power of the lungs, and tends to destroy the health.

Tobacco adds a poisonous impurity to the blood, and thus gives the lungs too much work to do. We can smell the tobacco on the breath of one who uses it, because it has made its way into the blood, and the lungs are throwing it off as an impurity.

In both smoking and chewing the peculiar poison of tobacco is taken into the blood through the mouth. It has a quieting effect, because it dulls the nerves when they ought to be both strong and active.

The burning tobacco makes the air impure; this is breathed directly into the lungs. The fumes irritate the delicate membrane that lines these organs. Young children, and non-smokers in delicate health have been known to suffer from breathing air loaded with fumes of tobacco smoked by others.

Cigarettes are more injurious than cigars, and there is a suspicion that they sometimes contain opium, in addition to the poison of tobacco.

Smoking injures the lining membrane of the mouth, causing the throat to become sore; it irritates the bronchial surfaces of the lungs, and makes a cough worse.

Alcohol enters the blood and makes it impure. The lungs receive this impure blood, and at once begin to throw off the alcohol. We can smell the alcohol on the breath, because the lungs expel it with other impurities. Alcohol weakens the lungs, while it also gives them more work to do.

The use of liquor hardens the delicate partition between the air-cells and blood tubes of the lungs. This directly hinders the purifying of the blood. Sometimes it causes the incurable disease, alcoholic consumption. It has been thought that the use of liquor would cure consumption. This is a mistake. Nothing is more certain than that alcohol often causes consumption.

The notion that alcohol in any form will help one to bear the cold, is a false one. Quite the reverse is true. Men who use liquor can not endure exposure to cold and fatigue as well as men who do not. Alcohol lowers the warmth of the body and lessens all the powers of activity and endurance. Expeditions to the arctic regions have proved that men endure cold better and do more work without alcohol than with it. Alcohol partly deadens the nerves in the walls of the blood-vessels that control the motion of the blood. These nerves

relax, and more blood than necessary comes to the surface of the body, where it rapidly cools. For a few minutes the drinker feels warmer, but in a little while he is colder than he would have been if he had not taken the alcohol. Experiments on animals have shown that their temperature is lower after a dose of alcohol, and if the dose is large, it does not come up again to the standard for hours afterward. In fatal doses, the temperature keeps on sinking until death takes place.

Organs that aid the Lungs in purifying the Blood.—The waste matters in the blood are chiefly carbonic acid gas, water, and various salts. These are produced everywhere in the body by the changing of food and air into flesh, bones, nerves, etc. The blood gathers these impurities into itself, and certain organs through which it flows are constantly taking them from the blood and casting them out of the body.

The lungs remove carbonic acid gas; the kidneys and skin are constantly taking out water and salts. It requires the healthy action of all these organs to keep the blood purified. If they fail to do their work well, ill health is the result.

The kidneys are two bean-shaped bodies, about half the size of the fist, located in the upper back part of the abdomen, one on each side of the aorta. Branches from this great artery convey some of the blood through the kidneys. In the capillaries of the kidneys, some of the salty water of the blood is taken out and passed into the bladder, and the purified blood is returned to the general circulation.

The kidneys of those who use alcohol are liable to various diseases:

1. They may be overworked. The thirst caused by alcohol leads to the drinking of a great deal of liquid which the kidneys must remove.

2. Substances which have not been properly prepared for removal by other organs, owing to the action of the alcohol, are brought into the kidneys and irritate them.

3. In the kidneys, as in the muscles and liver, alcohol causes the growth of too much connective tissue and fat, which crowd out the real kidney substance.

4. Taken in large quantities, alcohol passes unchanged through the kidneys, injuring their delicate tissues.

A fatal disease of the kidneys, called Bright's disease, often results from the use of alcoholic liquors.

Summary for Review.

1. *What is air?*
   A gas which we breathe into our lungs and out again continually.
2. *How long can we exist without any air?*
   Not five minutes.
3. *Which part of the air do we use in breathing?*
   The oxygen gas, which forms about one fifth of the air.
4. *What is the nature of oxygen?*
   It unites with other substances, causing what we call burning.

5. *Why do we need oxygen?*
   It becomes a part of the blood, and helps to warm and clean the body.
6. *What are the lungs?*
   They are the organs of breathing; they fill the chest and surround the heart.
7. *How does air from the outside get into the lungs?*
   It rushes in through the nose and mouth.
8. *How often do we breathe?*
   About eighteen times in a minute; exercise causes us to breathe faster.
9. *Of what are the lungs composed?*
   Chiefly of blood tubes and air-passages.
10. *What are the blood tubes in the lungs for?*
    To convey the impure blood from the heart through the lungs to be purified, and to return the pure blood to the heart.
11. *Name the air-passages.*
    The nose, trachea, bronchial tubes, and air-cells.
12. *What is the trachea?*
    The pipe that leads from the back of the throat to the lungs.
13. *Describe the size of the trachea.*
    It is an inch in diameter and four or five inches long.
14. *Where is the voice made?*
    In the larynx at the top of the trachea.
15. *Of what use is the epiglottis?*
    It closes like a lid over the larynx to prevent food from getting into the air-passages.
16. *What are the bronchial tubes?*
    The branches of the trachea in the lungs.
17. *What are the air-cells?*
    The tiny, thin sacks that form the inner and closed ends of the air-passages.

18. *How are the air-cells and blood capillaries arranged in the lungs?*
They are placed side by side, so that the air and blood are separated only by a very delicate partition.
19. *What changes take place in the air in the lungs?*
It gives some of its oxygen to the blood, and receives carbonic acid gas and other impurities from the blood.
20. *What changes take place in the blood in the lungs?*
It receives oxygen from the air, and gives carbonic acid gas and other impurities to the air.
21. *What is meant by the pulmonary circulation of the blood?*
The flowing of the blood from the right side of the heart, through the lungs, and back to the left side of the heart.
22. *What is this circulation for?*
To purify the blood and to give it oxygen.
23. *What is the systemic circulation?*
The flowing of the blood from the left side of the heart, through all the body, and back to the right side of the heart.
24. *What is this circulation for?*
To nourish and clean the body.
25. *How is the body warmed?*
By the slow uniting of oxygen with the food and waste matter of the body.
26. *What is the normal temperature of the body?*
About 98° Fahrenheit.
27. *What does a change in temperature indicate?*
It usually indicates ill health.
28. *What is the change of air in rooms called?*
Ventilation.

29. *Why should we never keep a lamp burning in a room at night?*
Because it adds to the impurity of the air.
30. *What happens when we try to study in close rooms?*
We become dull and restless and get a headache.
31. *How may rooms be ventilated without causing draughts?*
By raising the windows a few inches and fitting a board under the lower sash.
32. *What is consumption?*
A disease of the lungs caused by impure blood and the want of pure air.
33. *What is the best cure for consumption?*
Pure dry air and outdoor life.
34. *How does tobacco affect the strength of the lungs?*
It weakens the muscles that perform the act of breathing.
35. *How does it give the lungs too much work?*
By adding another impurity to the blood.
36. *What shows the presence of this impurity in the blood?*
The fact that we can smell the fumes of tobacco on the breath of the person who uses it.
37. *How does tobacco smoke affect the lungs?*
It irritates the delicate membrane that surrounds and lines the lungs.
38. *How does alcohol affect the lungs?*
It gives them additional work by making the blood impure.
39. *How does alcohol affect the delicate partitions between the air-cells and blood tubes?*
It hardens them.
40. *What disease may be caused by alcohol?*
Consumption.

41. *Will the use of liquor cure consumption?*
It more often causes than cures consumption.
42. *Does alcohol aid in warming the body?*
No ; it cools the body.
43. *What do the skin and kidneys chiefly do?*
Remove water and salts from the blood.
44. *How may alcohol injure the kidneys?*
By causing them to overwork, by clogging them with fat, and by irritating them.
45. *What fatal disease is often caused by alcohol?*
Bright's disease of the kidneys.

Fig. 34.

Diagram of Brain and Spinal Nerves.

CHAPTER X.

THE BRAIN AND NERVES.

Definitions.

çĕr′e brŭm, the upper and larger part of the brain.

çĕr e bĕl′lum, the lower and smaller part of the brain.

erā′ni al, belonging to the cranium, or skull.

me dŭl′lă ŏb lŏn gā′tă, the oblong marrowy mass at the top of the spinal cord.

mō′tor, giving motion.

par ăl′ȳ sĭs, loss of motion.

sĕn′sor, conveying sensation.

The nervous system unites and controls the action of the various organs, so that they all work in harmony as parts of one body. This system consists of a large organ, called the *brain*, and a great number of long, thread-like *nerves* that connect the brain with all the other parts.

The brain is the seat of action of the mind, and the nerves connect the brain with the skin for feeling, with the muscles for motion, with the eyes and ears for seeing and hearing, and with the great organs for life.

The nervous system is composed of soft, pulpy substances of two kinds: (1) *gray matter*, which is collected into centers, and (2) *white matter*, which is formed into long nerves.

The nervous system somewhat resembles the telegraph. The centers of gray matter are like the

offices for receiving and sending messages; the white nerves are like the wires that connect the offices and carry the messages.

The brain is composed of gray matter in its outer part, and of white matter in its inner portion. For protection, it is wrapped in delicate covers and surrounded by the strong bones of the skull. The brain is egg-shaped, and weighs about three pounds. Its surface is composed of folds called *convolutions*. (Fig. 35.)

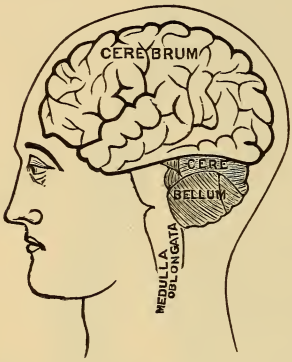

Fig. 35.

DIAGRAM SHOWING PARTS OF THE BRAIN.

The brain is a double organ, being separated into a right and a left side, called *hemispheres*, which are united at the base of the brain. It is also divided into an upper portion, called the *cerebrum*, and a lower part, known as the *cerebellum*.

The cerebrum is much the larger portion, and fills the front and upper part of the skull. This part of the brain appears to be the seat of thought.

The cerebellum fills only the lower rear portion, and appears to govern the movement of the muscles.

All parts of the brain join at its base and form an under and middle part called the *medulla oblongata*. From this part arise twelve pairs of nerves called **cranial nerves,** that connect the brain with the eyes, ears, nose, and mouth, and with the lungs and stomach.

The spinal cord extends from the brain down the back, through a canal which is formed by openings in the vertebræ of the backbone. It is the main trunk from which the nerves branch. It is composed of white matter, having some gray matter within.

The spinal nerves are long, slender bundles of white fibers. They branch from the spinal cord in thirty-one pairs. These bundles separate into smaller and smaller divisions until their fibers are distributed to all parts of the body. (See Fig. 34.)

Some of these fibers have their outer ends in the skin, and are used in feeling. These are called *sensor* fibers. When any thing touches the skin, the message is sent along the fibers to the brain, and the mind learns that the body is touched at that place.

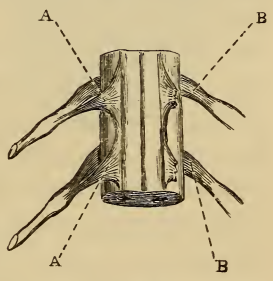

Fig. 36.

SECTION OF SPINAL CORD.

a, *a*, motor fibers; *b*, *b*, sensor fibers.

Other fibers have their outer ends in the muscles, and are used in causing motion. These are called *motor* fibers. (See Fig. 36.) When we wish to move any part of the body, the brain sends messages along the fibers that lead to the proper muscles to make them contract. The muscles can do nothing of themselves; the brain and nerves give them their power to move, and guide them.

If the sensor nerves from any part of the skin were destroyed, we could not feel anything touch that part, because no message could come to the brain. If the motor nerves that lead to the muscles of any

part of the body were destroyed, we could not move that part, because no message could be sent from the brain to the muscle. Disease or injury that destroys our feeling or power of motion in any part, is called *paralysis*.

The nerves that supply the heart with its great force for circulating the blood, and are connected with the stomach and other great organs, are not joined directly with the brain. We do not need to think about these organs upon which our life depends, in order to keep them at their work. They work on at all times, even while we sleep or while we are busy at study. They receive their nerves from many small centers, or "little brains," which are placed wherever they are needed in the body. These small centers and their nerves are called **sympathetic nerves**. They connect all the organs in such a way that life goes on, and so that one part can not suffer without the sympathy and aid of all the other organs.

The hand has more **nerves of touch** in its skin than other portions of the body. Persons who are blind use the fingers in touching the raised letters of their books, and learn to read in this way.

We perceive odors by means of the delicate **nerves of smell** on the inside of the nose. These nerves lead directly from the brain into the nose for this purpose. It is believed that in smelling anything tiny particles come from the object into the nose and touch the nerves of smell. Smell helps us to choose healthful food and drink, and to know when the air is impure. It is unsafe to use food or drink, or to breathe air that has a bad odor.

The nerves of taste are situated in the mouth. Some of the nerves of the mouth simply feel things, while others are used in tasting. The nerves of taste start from the brain and end on the rough surface of the tongue and in other parts of the mouth.

When any substance is dissolved in the saliva and absorbed into the lining membrane of the mouth, the tiny particles thus absorbed touch the ends of the nerves and produce taste. We can only taste such things as can be dissolved in the saliva. (See Fig. 37.)

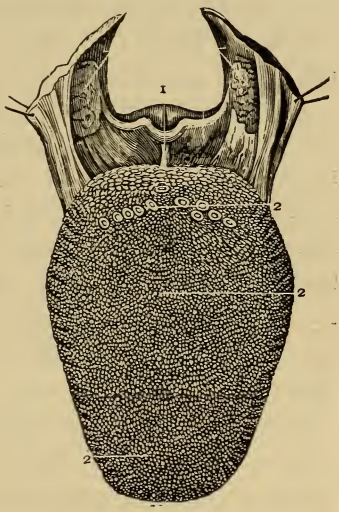

Fig. 37.

THE TONGUE.

1, epiglottis; 2, papillæ of the upper surface.

Taste helps us in the choice of our food. We should not eat anything that has an offensive taste. Wholesome food usually has a pleasant taste; but some poisons also are pleasing to the taste. Therefore we must not eat things simply because we like them. Substances of very strong or burning taste destroy the delicacy of the nerves.

Tobacco is very strong, and partially deadens the nerves of taste. Those who chew tobacco can not taste delicate flavors. For this reason they are usually disposed to over season their food. This only adds to the harm already done by the tobacco.

Alcoholic drink destroys the acuteness of the nerves of taste. If any one holds weak alcohol in his mouth for a short time, he can scarcely taste anything until the effect of the alcohol has passed off.

Injuries to the Brain and Nerves.—If the nerves are injured, or too greatly excited in any way, the feeling they cause is painful. Our dread of pain makes us careful to avoid injury. If any part of the body becomes diseased, we usually have pain in it because the nerves are sore. Pain frequently shows us where disease is, and enables us to try to relieve it. If we use any part too roughly, or for too long a time, it pains us.

The brain and nerves are easily injured by wrong use or overwork. They wear out rapidly, and, like all other parts, depend upon the blood for nourishment and repair. The brain requires more blood than any other part. To be well, it must be nourished by pure blood. To be strong, we require exercise of both body and mind. We must think and study, work and play; but not too hard nor too long at a time.

After we have used the brain it needs rest. Overwork, loss of rest, long sickness, great anxiety, or continued excitement, weaken the brain. A man may become so weakened or diseased as to lose the right use of his mind, and we then say he is insane.

The best rest for a tired brain is sound sleep. During sleep the brain is relieved from work, and the blood repairs it for new service. Those who use the brain much need much sleep. Children need

more than older people because they are growing. Change of work partially rests the brain. If the brain is tired with hard study in school, we may rest it by outdoor play.

The brain is easily injured by blows on the head and neck. No one should ever be struck about the face or head. A slight blow on the head may prove fatal.

Alcohol, passing from the stomach into the blood, is quickly carried through the system and brought into contact with the nerves, which it paralyzes in proportion to the amount taken.

Alcohol has a greater attraction for brain and nerve matter than for any other parts of the body. In cases of death from alcohol, more of the poison is often found in the brain and nerves than in any other organs. Small blood-vessels are very numerous in the brain, and they are soon distended and gorged with blood after alcohol is drunk. This excites the mind to work, but the quality of the work is poor, for the mind can not exercise close attention or good judgment. Reason and conscience usually fail first in the drinker. The will is then affected. A single drink of alcohol may weaken not only the judgment, but the will which controls the actions and emotions. A man who is only slightly under the influence of liquor is often noisy, and may do things he would condemn when perfectly sober. If more alcohol is taken, the voice of conscience and reason is silenced. The words of such a drinker are then apt to be still more offensive; his conduct is often dangerous until his brain and nerves become

so deadened that he has no control over his muscles, and complete insensibility follows. The continued use of alcohol permanently injures the power to will, and to carry out the purposes of the will; but the enfeebled will yields to the temptation to drink as appetite increases, until all sense of right and wrong is gone. The brain and the whole nervous system are poisoned. A fearful disease called delirium tremens, or trembling madness, which is caused by the action of alcohol on the nervous system, often ends with death. Most of the criminals in our jails and penitentiaries have been brought there by alcohol.

As alcohol is a brain poison, it frequently causes *insanity*. The drinking habits of parents often cause idiocy in their descendants, involving not only their children, but grandchildren. When these results fall short of insanity or idiocy, children frequently *inherit diseases of the brain and nerves* as well as badly balanced mental and moral natures. Thus, a person who begins to take alcoholic drinks runs the risk not only of blighting his own life, but that of his children and of his grandchildren.

Summary for Review.

1. *What is the nervous system?*
   The brain and nerves that control all the other parts of the body.
2. *Of what are these composed?*
   Of soft and pulpy gray and white matter.
3. *What is each kind for?*
   The gray is collected into centers to receive and send messages; the white forms the nerves for carrying the messages.

4. *What is the brain?*
The great nervous center filling the skull.
5. *Describe it.*
It is a soft, egg-shaped mass, weighing about three pounds, and covered with wrinkles.
6. *How is it divided?*
Into right and left hemispheres, joined at the base.
7. *What are its parts?*
The cerebrum, cerebellum, and medulla oblongata.
8. *What is the cerebrum?*
The larger, upper portion that is used in thinking.
9. *What is the cerebellum?*
The smaller, lower portion used in controlling the muscles.
10. *What is the medulla oblongata?*
The portion that unites the other parts and joins them to the spinal cord.
11. *Describe the cranial nerves.*
They are twelve pairs of nerves that pass out from the brain through openings in the cranium, or skull, and which extend to the eyes, ears, nose, and mouth, and to the lungs and stomach.
12. *What is the spinal cord?*
The large mass of nerves that extends from the brain, and lies in the backbone.
13. *What are the spinal nerves?*
Branches from the spinal cord leading to all parts of the body.
14. *What are sensor nerves?*
The nerves that end in the skin, and that convey feelings to the brain.
15. *What are motor nerves?*
The nerves that join the muscles to the brain, and that we use in moving the muscles.

16. *What are sympathetic nerves?*
The centers and nerves that control the action of the vital organs.
17. *What is touch?*
The sensation the mind gets from the skin when it comes in contact with anything.
18. *What is smell?*
The sensation of odor we get from the nerves of the inside of the nose.
19. *What is taste?*
The sensation we get from some of the nerves in the mouth.
20. *How may we make the brain strong?*
By exercising it and resting it properly.
21. *How is the brain rested?*
By sleep and change of work.
22. *How does alcohol affect the nerves?*
It tends to paralyze them.
23. *What property in the alcohol causes this?*
Its narcotic quality.
24. *Why does alcohol so seriously affect the brain and nerves?*
Because an unusually large proportion of it goes to those organs.
25. *How does the continuea use of alcohol affect the will?*
It greatly weakens the power to make and to carry out any good resolutions.
26. *What is true of alcohol and insanity?*
It is the chief cause of insanity.
27. *How do the drinking habits of parents affect their children?*
Such habits in parents often cause idiocy, epilepsy, insanity, or badly balanced mental and moral natures in their children and children's children.

CHAPTER XI.

SIGHT.

Definitions.

ā′que oŭs, watery.
hū′mor, moisture ; the name given to the fluid parts of the eye.
ī′ris, the colored, curtain-like ring of the eye.
ŏp′tic, relating to sight.
pū′pil, the opening in the iris of the eye.
re frăc′tion, a change in the direction of a ray of light.
vĭt′re oŭs, resembling glass, jelly-like.

In seeing things we do not feel them as we do in touching, tasting, and smelling. Objects may be far distant from us, yet we can see them. We see things by the light which comes from them to us.

Light is not a substance sent off from objects, but is believed to be waves in the ether which fills all space ; these waves pass off in all directions in straight lines from light-giving bodies. The stars are millions of miles from us, yet their light is brought to us through the ether that fills the space between them and us.

Light from the thing that we see comes into the eye and forms a small image, or picture, of the object on the inside of the back portion of the eye. A lens in the front part of the eye brings the lines of light together to form an exact but very small image of the object on the inner back part of the ball, just as

the lens in the front of a photographic camera helps to throw the image on the screen behind. (See Fig. 38.) A whole landscape may be pictured in the eye on a space not larger than the nail of the little finger.

The nerves of sight are called **optic nerves.** They lead from the eye to the brain. The mind learns of the image in the eye by the sensation which these nerves cause in the brain. Experience teaches the mind to judge from this sensation produced upon the brain of the size, shape, color, and distance of objects.

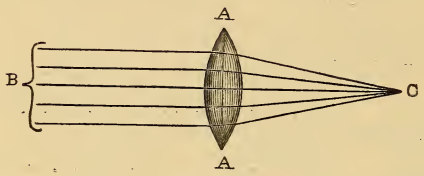

Fig. 38.

DIAGRAM TO SHOW REFRACTION OF LIGHT.
a, lens; *b*, parallel rays; *c*, point of convergence.

The sense of sight guides us in moving about among the things that surround us; it protects us by showing us danger; it enables us to find what we wish; it tells us much of the nature of objects that are round about us, and thus helps to educate us.

The eye-ball is nearly round, and about an inch in diameter. Its outer solid part is formed of three coats one within another:

1. The *sclerotic* is the outer coat, and is white and tough.

2. The *choroid* is the middle coat, and is black and full of blood-vessels.

3. The *retina* is the inner coat, and is made up of a delicate network of branches of the optic nerve.

The front of the eye is like a curtained window for admitting the light. The outside of this portion,

called the *cornea*, is clear; inside is the *iris*, which gives color to the eye; the round hole in the center of the iris is called the *pupil*. The iris regulates the amount of light that goes into the eye by making the pupil smaller when the light is strong, and opening the pupil when the light is weak.

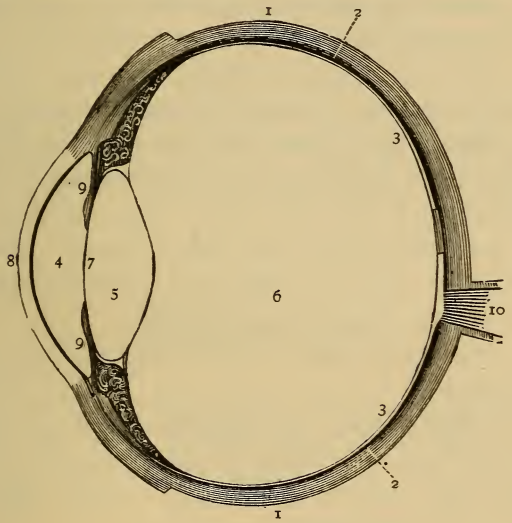

Fig. 39.

SECTION OF EYE.

1, sclerotic coat; 2, choroid coat; 3, retina; 4, aqueous humor; 5, crystalline lens; 6, vitreous humor; 7, pupil; 8, cornea; 9, iris; 10, optic nerve.

The eye-ball is filled with three kinds of clear, jelly-like substance called humors:

1. The humor in the front is called the *aqueous humor*, because it is like water.

2. The second is just behind the pupil, and is called the *crystalline lens*, because it resembles crystal and has the shape of a lens.

3. The humor that fills the back portion is called the *vitreous humor*, because it is glassy in appearance. (See Fig. 39.)

How the Eye is Protected.—The eye is protected in many ways. A bony arch surrounds it, and shields it from blows, except in front.

The brow and lashes shade the eye, and help to prevent perspiration from running into it.

The lids close over it in sleep, and shut quickly if there is danger of anything striking the ball.

The under side of the lid is covered with nerves, which feel the least speck that gets under the lid or on the ball.

The tears flow upon the ball to keep it moist and clean, and to help to wash out anything that may scratch or otherwise injure the ball.

The eye rests upon a soft, fatty cushion, behind and beneath it.

How Sight may be Injured.—We should not strain the eyes nor make them tired by sewing or reading small print in a dim light. If the eyes smart or burn, they need rest.

We should shield them from very brilliant lights, and should not allow a strong light to shine directly into the eye. In reading, the light should come upon the page from the rear or side. This will light the page and shield the eye. We should hold the book at least a foot from the eyes. To hold it nearer tends to make us near-sighted.

We should not rub the eyes. If anything gets under the lids we should let the tears wash it out. Rubbing and wiping inflame the eye.

Alcohol injures the delicate nervous surface of the retina upon which the image of all objects that we look at is first impressed. All the senses, but particularly sight, are blunted by small doses of alcohol.

Tobacco smoke injures the eye. It causes an undue opening of the pupil, confusion of vision, bright lines, specks, and long retention of images on the retina.

We may strengthen our eyes by proper and careful use. By noticing what we see, the eyes will become keener. Practice in judging of size, direction, distance, and color will make our eyes quick and accurate.

Summary for Review.

1. *How do we see?*
   Light from an object forms a small, bright image of the object on the back part of the inside of the eye, which causes in the brain the sensation of sight.
2. *What is the name of the nerve of sight?*
   It is called the optic nerve, and leads from the eye to the brain.
3. *What are the coats of the eye?*
   The ball has three coats that form its wall: the sclerotic, the choroid, and the retina.
4. *How is the front of the eye formed?*
   Like a window for letting in the light.
5. *What is the iris?*
   It is the colored curtain in front of the eye for regulating the quantity of light admitted.

6. *How does it do this?*
   By opening the pupil when the light is dim, and closing the pupil when the light is strong.
7. *What are the humors of the eye?*
   The clear, jelly-like substances that fill the eye.
8. *What humors are there?*
   Aqueous, crystalline, and vitreous.
9. *How are the eyes protected?*
   By the projecting bones about the eye, by the lids, the lashes, and the tears.
10. *How should the light fall on the book we are reading?*
    From behind us or from our side.
11. *How does alcohol affect the eye?*
    It injures the delicate nervous surface of the retina.
12. *How does tobacco smoke affect the eye?*
    It causes the pupil to dilate, bright lines and specks to appear on the retina, and it creates a confusion of vision.

CHAPTER XII.

HEARING AND THE VOICE.

Definitions.

au′di to ry, relating to hearing.
cŏrd, a musical string; the two string-like folds of the larynx.
tym′pa nŭm, the drum of the ear; the middle ear.
vō′cal, relating to the voice.

WE do not touch the thing we hear; the sound comes from it to us and enters the ear. **Sound** is not substance, but consists of waves that are sent off from the sounding object and carried in all directions by the air. We hear the school-bell by the sound that comes from it, through the air, to us.

Sound enters the ear, and by moving the delicate nerves of its inner portion, causes the sensation which we call hearing. The nerves of hearing are called *auditory nerves;* they connect the inner part of the ear with the brain.

The most important use of hearing is that it guides us in the use of language. Children who are born deaf seldom learn to speak any language, because they can not hear. People who are not born deaf, but who lose the sense of hearing, often lose the power to speak, for the voice is guided by the ear.

The ear has three divisions: (1) the outer, (2) the middle, (3) the inner.

The outer ear is the part we see, together with the tube that leads from it into the middle part; this tube is about an inch long. The shell-shaped outer portion of the ear aids in catching the sound.

The middle ear is like a small room separated from the outer ear by a thin membrane that is stretched across the tube of the ear. This part is called the *tympanum*, or *drum* of the ear. The middle ear is filled with air, and has a curious chain of bones extending across it. (Fig. 40.)

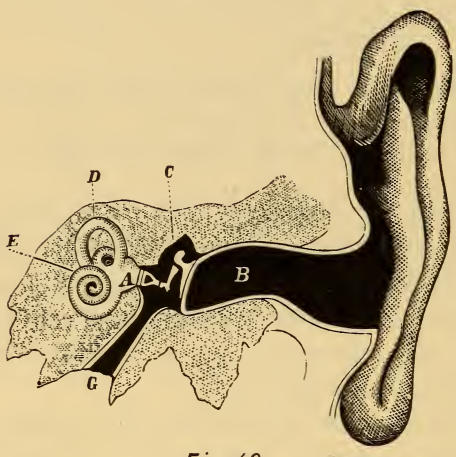

Fig. 40.

DIAGRAM TO SHOW THE PARTS OF THE EAR.

A, inner ear; *B*, outer ear tube; *C*, middle ear; *A*, *D*, *E*, chambers of the inner ear; *G*, air tube from the ear to the throat.

The inner ear contains the nerves of hearing; the outer and middle parts bringing the sound to the inner portion. This part is surrounded by a strong, bony wall, and contains a fluid resembling water. The delicate nerves are moved by this fluid as the sound jars and moves it.

Care of the Ear.—We should not pick the ears with pins or sticks. The bitter wax of the outer ear is designed to protect the ear from insects, and should therefore not be removed. We should avoid

deafening sounds. We should not expose the ears to very great cold, nor to draughts of cold air. Under no circumstances should any one be struck on the ear.

Two distinct affections of the ear are produced by the use of **tobacco** : one is an injury of the auditory nerve, causing a roaring sound and diminished acuteness of hearing; the other is a frequently recurring inflammation of the middle ear.

The larynx is the curious box in which the voice is made. It is in the front part of the neck, below the back of the tongue, and at the upper end of the trachea. It forms a part of the air-passage to the lungs. It is triangular in form, about two inches long, and an inch in diameter. (Fig. 41.) You can readily feel the larynx with your hand, and in many persons it is plainly visible. The larynx is often spoken of as "*Adam's apple.*"

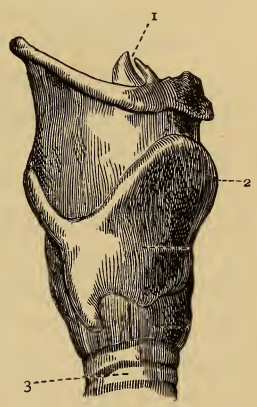

Fig. 41.

RIGHT SIDE OF LARYNX.
1, epiglottis; 2, "Adam's apple;" 3, trachea.

The *vocal cords*, which make the sound of the voice, are in the larynx. They are formed of folds of the membrane that lines the larynx. These are four folds or cords on the sides of the larynx, two above, called the false cords, and two below, called the true cords, because it is by the vibration of the lower ones only that sound is made. When we are not making a sound,

these folds are loose and simply form the lining of the larynx; but when we wish to make a sound, we draw upon certain muscles that stretch these folds across the larynx, so that the force of our breath against them causes them to vibrate. (Fig. 42.) The opening between the vocal cords, through which the air passes, is called the *glottis*.

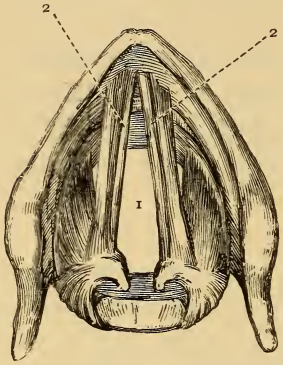

Fig. 42.

GLOTTIS AND VOCAL CORDS.
1, glottis; 2, cords.

We can alter the shape and position of the vocal cords in several ways so that they will make many different sounds. If the cords are drawn tightly, they vibrate rapidly and produce an acute sound; when they are relaxed they are thicker and produce a graver sound.

We also use the nose, tongue, and lips for changing these sounds, and for making the syllables and words of our language. In order to have a full, strong voice, we must have a full, strong chest, and speak with plenty of air in the lungs. A weak voice is usually a sign of faulty breathing. We can improve the force and distinctness of the voice by proper exercises of the vocal organs in speaking. Singing and reading aloud tend to improve the voice.

The habitual use of **tobacco** injures the quality and character of the voice. Smoking creates a reedy sound which hinders purity of tone, and renders the voice grating to the ear. Chewing, by its exhausting

effect on the salivary glands, makes the voice harsh and disagreeable.

Summary for Review.

1. *What is it that comes into the ears when we hear?*
   Waves of sound from the thing we hear.
2. *How does sound affect the ear?*
   It moves the delicate nerves of hearing in the ear.
3. *Of what use is hearing?*
   It enables us to learn to speak as we hear others speak.
4. *What other misfortune often accompanies deafness?*
   Loss of the power of speech.
5. *How many parts to the ear?*
   Three: outer, middle, inner.
6. *Which of these contains the nerves of hearing?*
   The inner ear.
7. *What are the outer and middle parts for?*
   To aid in bringing the sound into the inner part.
8. *Of what use is the bitter wax in the ear?*
   It protects the ear from insects.
9. *How should we take care of the ears?*
   The ear should not be exposed to severe cold. It should not be struck in any way.
10. *How does tobacco affect the hearing?*
    It causes inflammation and dulls the sense of hearing.
11. *What is the larynx?*
    The box in which the voice is made.
12. *Where is it?*
    At the upper end of the traches.
13. *What other name is often given to the larynx?*
    Adam's apple.

14. *What are the vocal cords?*
Folds of membranes in the larynx.

15. *What causes the sounds of the voice?*
We stretch the cords across the larynx so that our breath causes them to vibrate.

16. *How do we change the sounds?*
By altering the tension of the cords, and by using our tongue and lips in speaking.

17. *How may we improve the voice?*
By proper exercises in speaking, singing, and reading.

18. *How does the use of tobacco affect the voice?*
Smoking creates a reedy sound, which hinders purity of tone, and chewing makes the voice harsh.

CHAPTER XIII.

WHAT TO DO IN CASE OF ACCIDENTS.

Definitions.

ăm′bu lançe, a cart for conveying the wounded.

ăn′tĭ dōte, a remedy which counteracts the effects of a poison.

ăp′oplĕx y, sudden loss of consciousness caused by pressure on the brain.

cau′ter ize, to burn with a hot iron or with a caustic.

hĕm′ŏr rhage, a discharge of blood from the blood-vessels.

lock′jaw, a contraction of the muscles of the jaw, which suspends their motion.

pŭnc′ture, a wound made by a point or sting.

sŭf fo ca′tion, a smothering or choking.

An accident may happen at any moment, when it is either impossible to get a physician or dangerous to wait for one. A fractured bone, a cut finger, a sprained ankle, a sudden faintness, poisoning—these and many other accidents are likely to happen to us at any time. It is therefore evident that the study of these things is of the utmost importance. A boy or girl who knows how to act under such circumstances is worth a dozen who can only stand around and wonder what ought to be done.

Pure Air.—Do not forget that the first thing the patient needs is pure air. If the accident occurs on the street, do not allow a crowd to gather around; and if it occurs in the house, send all persons away

from the patient's room except those who are needed to give assistance.

How to Examine the Patient.—It is necessary that the injured person be examined with great care, as rough handling may increase the injury.

In case of any accident, send a message to the doctor, describing, as well as possible, the nature and urgency of the case, so that he may come prepared with everything that is necessary.

Find out whether or not the patient is unconscious. If there is complete unconsciousness, the arm when lifted and let fall offers no resistance and the various muscles act as dead weights. If the case is one of fainting, arrange the patient on his back, provide for his free breathing by opening tight clothes, etc., apply smelling salts to the nostrils or tickle them, and dash cold water on the face. In some cases, such as suffocation, it is necessary to establish artificial respiration. Fanning is often beneficial, and, where the patient is able to swallow, a few sips of a mixture of ammonia and water should be taken.

Stretchers.—If the accident occurs in a city where

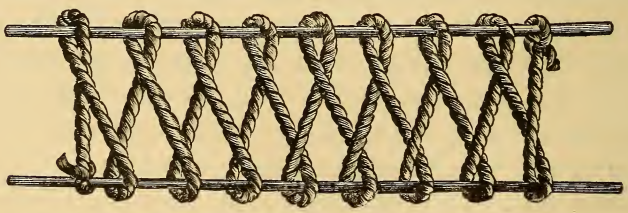

Fig. 43.

ROPE STRETCHER.

the ambulance service is established, no time should

be lost in calling an ambulance. If this cannot be done, a stretcher or some improvised chair should be

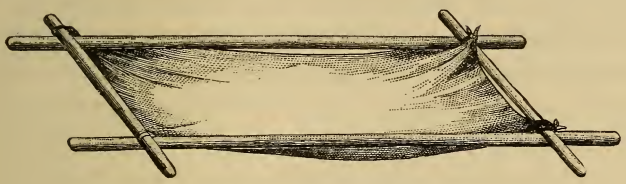

Fig. 44.

STRETCHER FORMED BY FOUR POLES.

used. Figs. 43 and 44 show two kinds of improvised stretchers.

Sunstroke and Exhaustion from Heat.—These conditions are caused by fatigue and exposure to heat. They most often occur in persons who are intemperate, physically weak, or not in good health. In sunstroke, the skin is hot, the pulse rapid, the patient breathes with difficulty, and is likely to be unconscious.

The patient should be placed on his back in a cool place, the clothing being removed from head and chest, and cold water thrown over the body. Apply ice to the head.

Fractures and Dislocations.—It is a mistake to think that a *fracture* must be set at once. It will do less harm to leave it a short time without splints than to apply them awkwardly. Place the injured part in the least painful position, and keep the patient quiet until a surgeon can be obtained. Support the affected part in some way so as to prevent painful twitchings. In the case of a broken limb,

elevate it slightly and apply cold water over the fracture, to keep the part from swelling.

In cases of *dislocation*, immediate action is of greater importance, as the muscular tension increases and the reduction then becomes more difficult. Dislocation of the fingers, except the thumb, can often be reduced by forcibly pulling them. In dislocation of the jaw, place the thumb on the back teeth and the fingers under the jaw. Depress the jaw forcibly, and at the same time lift the chin.

Sprains are serious injuries, and the most necessary thing is *rest*. While waiting for a surgeon, the injured parts may be gently wrapped in hot or cold water.

Contusions and Bruises result from falls, blows, or pressure, and when severe, are often followed by symptoms of shock. The most necessary treatment is rest and cold applications.

Wounds.—In the case of all wounds there are five points to be attended to: (1) arrest the bleeding; (2) clean the wound; (3) bring the cut surfaces together; (4) leave a way of escape for discharges; (5) protect the wound from the air.

If wounds are made which bleed rapidly, we must press on the veins or arteries that are cut. To do this, we must first find out where the wound is. Pressure may be made with the thumb or with a knotted handkerchief tied around the limb and twisted by means of a stick until the bleeding ceases. If the bleeding is from an artery, in which case it will come in jets of a bright red, the pressure must be made between the wound and the heart; if it is

from a vein, make the pressure at or beyond the wound.

Then wash the wound gently with water squirted from a clean sponge, dry it; place the edges naturally together with strips of adhesive plaster, and keep the wound quiet.

Wounds are likely to prove more dangerous when the patient is in the habit of drinking alcohol, as all the organs are injured and the natural healing forces of the body are thus weakened.

In a *punctured* wound, the first thing to be done is to keep it open until it heals from the bottom. If made by a splinter, thorn, piece of needle, or anything which has lodged in the skin, it is of the greatest importance that these substances be removed immediately, otherwise lock-jaw is likely to result. If they cannot be removed readily by scraping, or by a simple incision, send for the surgeon at once, before the foreign substance has a chance to travel inward from the surface.

Burns and Scalds.—Cut the clothing quickly from about the injured parts, taking care not to open any blisters that may have formed. Place the injured part in cold water. Then cover it carefully with water and flour, or water and soda, or with sweet oil; keep the wound quiet. When blisters form, their contents may be removed by slight punctures with a needle.

If the clothing should catch fire, wrap the body in a shawl or blanket to extinguish the flames. If these cannot be obtained, roll the patient on the ground, and wet the clothing.

Starvation.—In cases of starvation, give very small quantities of food at first; but give them often. Water may be given freely. The body should be kept warm.

Choking may be relieved by sharp blows on the back and shoulders, and by drinking cold water.

Hemorrhages.—Keep the patient quiet in a cool room, and if he is faint, let him lie down.

In cases of nose bleeding, if the patient is not faint, keep the head erect and find out from which nostril the blood flows. Then press the nostrils, raise the arm of the affected side above the head, and apply cold water or ice to the forehead or back of the neck; also let the patient take several deep breaths.

Fainting.—This is accompanied by unconsciousness on account of the small supply of blood to the brain. Provide fresh air; keep the head as low or lower than the feet; apply water and smelling salts.

Frost Bite.—Place the patient in a cold room, and rub the frozen or chilled parts with ice, snow, or cold water. Frost bites often prove fatal when the subject is a person who uses alcohol.

Apoplexy.—Loosen the clothing about the head, neck, and chest. Let the patient lie down, keep him quiet, and send for the doctor.

Foreign Bodies.—When foreign bodies, such as pins, crusts of bread, bones, etc., stick in the *larynx*, they cause trouble in swallowing and breathing, and give rise to the danger of suffocation. A sharp blow upon the back will sometimes remove the foreign body. If it does not, place the patient upon his

head and move him from side to side, striking him between the shoulders with the open hand.

Any foreign body in the *eye* will cause much pain. The tears will often wash out the cause of the trouble. If dust or cinders get into the eye, draw the upper lid down over the lower, and blow the nose violently. If the foreign substance is imbedded in the surface of the eyeball, call a surgeon at once.

Foreign bodies in the *ear* are often very troublesome, and if not removed may create inflammation, which may extend through the drum membrane to the brain. If the substance is hard, hold the ear downward, and syringe it gently with warm water, taking care not to close the opening. Send for the doctor as soon as possible.

Insects may be washed out by filling the ear with warm olive oil.

When a foreign body is in one *nostril*, let the patient take a full breath, firmly close the mouth and the other nostril, and the air having no other way of escape, may push it out. Or, if the object is in sight, press the nostrils above the object and hook it out with a bent wire. Sometimes snuff will cause enough sneezing to send out the substance.

Venomous Bites.—In case of snake bites, or those from mad animals, the bleeding should be encouraged, not checked. Tie a handkerchief tightly about the limb just above the bite. Bathe the wound in warm water, and suck it, or apply cupping glasses. Then cauterize the wound deeply and poultice it. In case of snake bites, stimulants should be given.

Treat the bites and stings of insects with cool

lotions. Be sure that the sting is not left in the wound.

Poison Ivy.—In cases of poisoning by poison ivy, treat the eruption with a strong solution of bicarbonate of soda.

Poisons.—Poisons are often kept about the house for various purposes, as for cleaning brass, for disinfecting, etc. Many poisons so closely resemble articles in common use that all dangerous substances should be plainly marked. Never keep bottles containing poison with medicine bottles, and never under any circumstances take anything from a bottle without being sure of what it is.

In spite of every care, however, a poison may often be taken accidentally, and in such cases immediate action must be taken. One of the first things to do is to empty the stomach. This may be done by forcing the patient to swallow several cups of warm water, in which has been stirred a large teaspoonful of salt or ground mustard, or a quantity of warm soapsuds. The vomiting may also be hastened by forcing a spoon or feather down the throat.

Besides emptying the stomach, the effects of the poison may be counteracted by the action of some substance of a different nature. A list of the more common poisons which are likely to be taken accidentally is given below, with some of their antidotes to be used in cases of emergency, when a physician is not at hand and no time is to be lost.

The acids most likely to be used as poisons are *muriatic*, *nitric*, and *sulphuric*. These acids, if

swallowed, destroy the mucous membrane of the stomach, and, in sufficient quantities, they will corrode the entire walls of the alimentary canal. The *antidotes* are the various alkalies, such as strong soapsuds, chalk, saleratus in water, and lime-water.

The alkalies most likely to be used as poisons are *ammonia*, and some forms of *potassa*. These substances burn the walls of the alimentary canal. The *antidotes* are the vegetable acids, given in dilute form, such as weak vinegar, or tartaric acid dissolved in water. Oils, such as castor oil, linseed oil, sweet oil, or cream, may be used as antidotes of alkaline poisons. Vomiting should afterwards be provoked.

Common *arsenic*, in any of its forms, such as *white arsenic*, *Fowler's solution*, or *Paris green*, is a deadly poison. To relieve it, cause vomiting by the use of mustard or ipecac. The *antidote* is the hydrated peroxide of iron. Use lime-water if Fowler's solution has been taken.

Sugar of lead (acetate of lead) and *white lead* are poisons. Besides inducing vomiting, use Epsom salts as an *antidote*.

Any of the *mercurial preparations* are poisonous. Use white of egg and milk as *antidotes*.

The most common narcotic poisons are *alcohol*, *opium*, *aconite*, *belladonna*, *hemlock*, *digitalis*, *tobacco*, *nux vomica*, and *strychnine*. Empty the stomach by using mustard or alum. Give strong coffee. Keep the sufferer in motion as much as possible. In cases of poisoning by *nux vomica* and *strychnine* stop the spasm by the use of chloroform.

Intoxication.—Lay the patient on the side, with

the head elevated, and try to induce vomiting. Slap the face or some sensitive part of the body.

Drowning, Asphyxia, Suffocation, Strangulation, etc.—Asphyxia is the name applied to the apparent death which is likely to occur from drowning or other causes. When a person is apparently drowned, the wet clothing must be promptly removed, and the body dried and well rubbed. Before beginning artificial respiration, the face should be turned down for a moment, and all accumulation of mucus removed from the mouth. In strangulation, remove all restriction from the neck.

In all these cases, artificial respiration should be employed immediately. The following directions are known as "Marshall Hall's Ready Method in Asphyxia":

1st. Treat the patient *instantly on the spot*, in the *open air*, freely exposing the face, neck and chest to the breeze, except in severe weather.

2d. In order *to clear the throat*, place the patient gently on the face, with one wrist under the forehead, that all fluid, and the tongue itself, may fall forward, and leave the entrance into the windpipe free.

3d. *To excite respiration*, turn the patient slightly on his side, and apply some irritating or stimulating agent to the nostrils, as *veratrine*, *dilute ammonia*, etc.

4th. Make the face warm by brisk friction; then dash cold water upon it.

5th. If not successful, lose no time; but, *to imitate respiration*, place the patient on his face, and

turn the body gently, but completely, *on the*

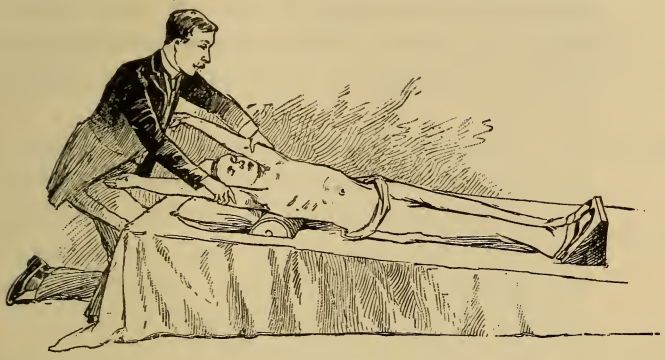

Fig. 45.

ARTIFICIAL RESPIRATION—INSPIRATION.

side, and a little beyond; then again on the face, and so on, alternately. Repeat these

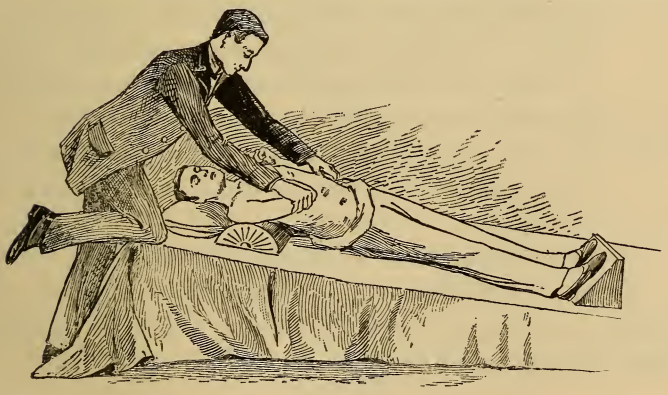

Fig. 46.

ARTIFICIAL RESPIRATION—EXPIRATION.

movements deliberately and perseveringly, *fifteen times only* in a minute. (When the

patient lies on the thorax, this cavity is *compressed* by the weight of the body and *expiration* takes place. When he is turned on the side, this pressure is removed, and *inspiration* occurs.)

6th. When the prone position is resumed, make a uniform and efficient pressure *along the spine*, removing the pressure immediately, before rotation on the side. (The pressure augments the *expiration;* the rotation commences *inspiration.*) Continue these measures.

7th. Rub the limbs *upward*, with *firm pressure* and with *energy*, the object being to aid the return of venous blood to the heart.

8th. If possible, substitute for the patient's wet clothing such other covering as can be instantly procured, each bystander supplying a coat or cloak, etc. Meantime, and from time to time, *to excite inspiration*, let the surface of the body be *slapped* briskly with the hand.

9th. Rub the body briskly until it is dry and warm, then dash *cold* water upon it, and repeat the rubbing.

Avoid the immediate removal of the patient, as it involves a *dangerous loss of time;* also, the use of bellows, or any *forcing* instruments; also, the *warm bath*, and *all rough treatment.*

Summary for Review.

1. *Why should we learn what to do in case of accidents?*
So that we are not at a loss how to act when a physician cannot be had.

2. *What is the first thing the patient needs?*
   Pure air.
3. *Why should you examine the patient very carefully?*
   Because rough handling is apt to make the injury worse.
4. *How should the patient be carried away?*
   In an ambulance or on a stretcher.
5. *What would you do in case of sunstroke?*
   Place the patient in a cool place, apply ice to the head and throw cold water over the body.
6. *What should be done in case of a broken bone?*
   Place the patient in an easy position and apply cold water till the surgeon comes.
7. *How would you treat a dislocation?*
   Try to pull the bone back into place.
8. *How should a sprain be treated?*
   Wrap the injured part very carefully in cloths, wet with hot or cold water, and let the patient rest quietly till the surgeon arrives.
9. *How are bruises caused and how relieved?*
   They are caused by falls, blows, etc., and require cold applications and rest.
10. *How are wounds treated?*
    Arrest the bleeding; cleanse the wound; draw the surfaces almost together, and protect the wound from the air by plaster or by bandaging it.
11. *How may bleeding be stopped?*
    By pressure made by the thumb or a knotted handkerchief, twisted by means of a stick.
12. *Where should this pressure be made if the bleeding is from an artery?*
    Between the wound and the heart.
13. *Where, if it is from a vein?*
    At or beyond the wound.

14. *How can you tell whether it is a vein or an artery that is cut?*
    The blood from an artery comes in jets of a bright scarlet, while that from the veins is of a dark red.
15. *How should a punctured wound be treated?*
    Keep it open till it heals from the bottom. Remove at once any obstacle that has lodged in the skin.
16. *What would you do for a burn?*
    Cut the clothing away; apply cold water to the burn and cover it with flour and water or with sweet oil.
17. *In case of starvation, how would you give food at first?*
    In small quantities, but often.
18. *How may choking be relieved?*
    By drinking cold water and by sharp blows on the back.
19. *How would you stop a hemorrhage?*
    Lay the patient down, keep him quiet and apply cold water or ice.
20. *What can be done for fainting?*
    Provide fresh air; keep the head lower than the feet; apply cold water and smelling salts.
21. *How may a frost bite be cured?*
    Rub the frozen parts with ice, snow, or cold water.
22. *What would you do in a case of apoplexy?*
    Keep the patient quiet; loosen his clothing and send for the doctor.
23. *How can you remove an obstacle from the larynx?*
    Give a sharp blow on the back.
24. *How from the eye?*
    Draw the upper lid over the lower and blow the nose violently.
25. *How from the ear?*
    Hold the ear down and syringe it with warm water.

26. *How from the nostrils?*
    By taking a deep breath and closing the mouth; by hooking it out with bent wire; or by using snuff.
27. *What would you do if bitten by a snake or a mad animal?*
    Encourage bleeding; bathe the wound in warm water and suck it; then cauterize and poultice it.
28. *What would you do if poisoned by poison ivy?*
    Treat the eruption with a strong solution of bicarbonate of soda.
29. *If a poison is taken accidentally what remedy should be used?*
    Empty the stomach; apply some antidote.
30. *How may intoxication be relieved?*
    Induce vomiting, and slap the patient's face.
31. *In cases of drowning, asphyxia, suffocation, and strangulation, what is the chief thing to be done?*
    To induce artificial respiration.

CHAPTER XIV.

IN AND ABOUT THE SICK-ROOM.

Definitions.

de-cŏm pō sĭ'tion, decay.
in dĭs pō sĭ'tion, a slight disorder or illness.
pŭlse, the beating of the heart.
sŷmp'tom, a change in the body which indicates disease.
thĕr mŏm'e ter, an instrument for measuring temperature.

As more or less sickness is likely to occur in every household, and as the surroundings prove so great a factor in the rapid recovery of the patient, it is well, whenever possible, to have a room set apart for the sick, specially arranged and ready to be used at a moment's notice. In selecting the room for this purpose, bear in mind the fact that it should be as remote as possible from the noise of the street. As a rule, a room at the top of the house is better, not only because it is furthest from the street, but because there is no noise of footsteps overhead, the air is purer, and in cases of contagious disease it is easier to keep the patient away from the other members of the family. The room should be large and have every convenience for ventilation; it should be on the sunny side of the house, as light and sunshine not only add to the cheerfulness of the room, but often serve as healthful stimuli.

In the furnishing of the room, the purpose in view should never be lost sight of. In a sick-room, more than anywhere else, cleanliness is an absolute necessity, and anything in the room which renders this condition difficult to attain is objectionable. First, as to the walls: it is better to paint than to paper them, even though the papering may be prettier. In the first place, wall-papers often contain arsenic or other injurious substances; and, in the second place, in case of a contagious disease, it is always easy to thoroughly scrub a painted room; while a papered room, to be well disinfected, must have the paper torn from the walls, a troublesome operation.

In furnishing the room, it is better to have nothing that is not really needed. The necessary things are bed, easy-chairs, lounge, and table. The best kind of bedstead is one made entirely of iron or brass with a mattress of woven wire. Rugs are better than carpets, as they can be taken out of the room and thoroughly shaken and cleaned. The furniture and wood-work should be plain so that it can be easily cleaned; for the same reason there should be no draperies or portières. Everything should be as simple as possible, but this does not mean that it may not be pretty and cheerful in appearance.

Never have stationary wash-stands in a sick-room. The holes leading to the drainage pipes are apt to emit injurious gases. When such wash-stands are found in or near the room, carefully cover all the holes leading from them, and use instead movable toilet articles.

It is well to have plenty of closet room for the storing of the various medicines and appliances necessary in case of sickness.

Whatever tends to keep the invalid quiet and contented is good for him; all excitement should be avoided. A tranquil, peaceful, and cheery atmosphere should prevail.

Under no circumstances should whispering be permitted in a sick-room. It irritates a patient and does more harm than straightforward speaking. If anything is to be said which the patient should not hear, it must be said outside the room.

Change the clothes of the bed and of the patient often; but be careful to keep them away from other clothes, especially in cases of contagious diseases. In such cases, all clothes should be carefully disinfected.

Ventilation.—A sick person needs two or three times as much air-space as one in good health. Although it is not possible to keep the air of a sick-room as pure as that outside, the aim should be to bring it as near that condition as possible.

In some cases, when the weather is cold or damp, open windows in the patient's room are dangerous. In such cases, the window in an adjoining room may be opened, and the air admitted from this room.

Especially at night, great care must be exercised in the ventilation of the sick-room, as the outside air is apt to be cold, while the air inside needs to be renewed as much at night as during the day. Air which is too cold is an evil, but not so great a one as foul air.

A sick-room odor is an evidence of poor ventilation and should be carefully guarded against.

When in cold weather the windows are open, the patient should be well protected from draughts.

How to give Medicines.—Medicines are usually taken in the form of pills, powders, or solutions. They should be kept in a dry closet, as dampness often spoils them. The place should also be cool and dark, as heat and light cause decomposition. Only small quantities should be kept on hand, and these should always be of the best quality.

All bottles should be distinctly labeled both as to name or character of the medicine and as to the dose to be taken. The label should be carefully read every time before giving the medicine. Do not leave the bottles uncorked, shake them before giving the medicine, avoid defacing the label, and *never* give a medicine in the dark.

The spoon or glass in which the medicine is given should be washed immediately after use. To prevent disagreeable tastes, hold the nose while swallowing; or before the patient takes the medicine give him some substance with a pungent flavor, as peppermint or wintergreen, which will weaken the sensibility of the nerves of taste. Licorice, dried orange, or a piece of bread may be used to remove disagreeable tastes.

Food.—In cases of sickness, the nature and quality of the food taken is a question of great importance. Everything should be of the best, and should be well prepared and served.

Before taking food to the sick, it should be tasted

to make sure that it is right. Too little food is usually better than too much ; but a system of regularity in giving food is of great advantage. The aim should always be to give what will be easy to digest, and of value after it is digested.

When the patient is weak and helpless, the food should be given slowly and in small quantities, with sufficient intervals between the swallowing.

When there are symptoms of great thirst and it seems wise not to give too much water, small pieces of ice will prove both valuable and refreshing.

Contagious Diseases.—In many diseases, such as small-pox and diphtheria, organic matters are thrown off from the persons of the sick which tend to cause the same disease in those who come in contact with them, or with the air through which they pass. In such cases, it is necessary (1) to ventilate the rooms properly to get rid of the impure air, and (2) to use disinfectants to destroy all such germs.

Disinfectants.—There are many substances used for disinfectants, but the following are the most useful : *sulphur* (used for fumigation), *carbolic acid*, *white vitriol*, *copperas*, and *chloride of lime*.

Bandaging.—The proper adjustment of bandages is a question of considerable importance in the treatment of wounds, etc. The bandage should be neither too loose nor too tight, as in the former case it is liable to slip, and in the latter, the pressure may be painful or may impede the circulation.

Among other forms of bandages may be mentioned the *roller bandage*, the *many-tailed bandage*, and the *triangular bandage*.

A *roller bandage* consists of a narrow strip of muslin, flannel, or other material, several yards long, evenly and tightly rolled together.

The advantage of this bandage is that it can be unwound as quickly as necessary, and thus the right smoothness and tightness may be secured.

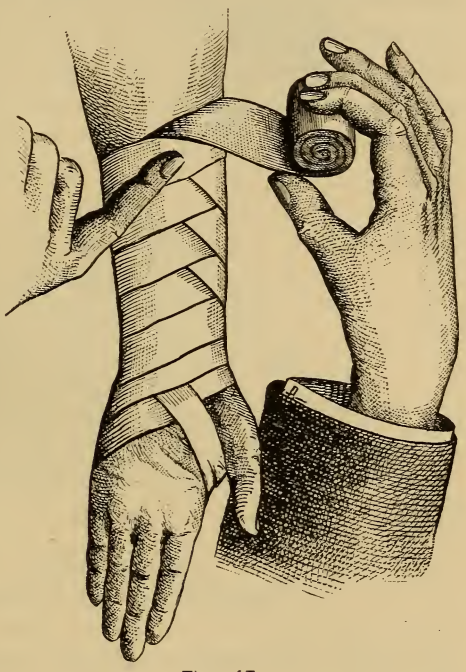

Fig. 47

THE ROLLER BANDAGE APPLIED TO THE ARM.

In bandaging any *limb*, always begin at the extremity and work toward the center of the body from left to right. In finishing off a bandage, one or two straight turns should be made and the end folded under and pinned. Another good way to finish off is to split the last quarter of a yard through the middle, wind the ends around the part in opposite directions, and tie them.

In bandaging a *hand* with the roller bandage, begin at the tip of the first finger and roll the bandage around it to the base, then turn it around the wrist

to keep it from slipping; then draw it up to the base of the second finger, wind up to the tip and back to the base; take another turn around the wrist, back to the root of the third finger, and so on until all the fingers are covered; then carry the bandage obliquely across the back of the hand, turn around the wrist, and carry back to the further side; continue this until the back and palm of the hand

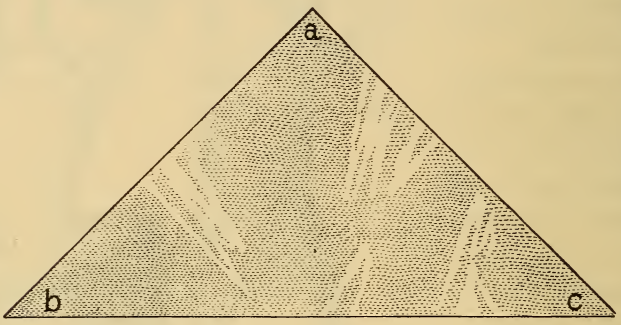

Fig. 48.

TRIANGULAR BANDAGE.

bc, lower border; *ab* and *ac*, side borders.

are completely covered; finally cover the thumb by making alternate turns about it and the wrist, and finish off at the wrist as described above.

Bandages for the *foot* are made in a similar way, varying slightly to adapt them to the structure of the foot.

The *many-tailed bandage* consists of a piece of muslin torn into strips from each side to within an inch or two of the center, which is left entire. It is

used chiefly when the part to be covered must not be moved.

The *triangular bandage* is one of the most useful forms for the head. A piece of muslin is cut into a triangle, which has a lower border and two side borders, a point and two ends.

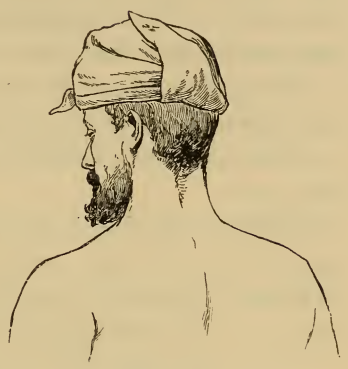

Fig. 49.

TRIANGULAR BANDAGE APPLIED TO THE HEAD.

The lower border is laid across the forehead, while the point hangs over the neck. The two ends are carried back over the ears, crossed behind, brought forward, and tied in front on the forehead. The point is then turned upwards and fastened with a pin above.

Poultices.—Poultices serve as convenient means of applying warmth and moisture. They are generally used to check inflammation, and they tend to relieve the pain, and to prevent the formation of pus. They may be made of various materials. One form consists of several thicknesses of lint or soft cloth wrung out in hot water.

Linseed poultices are often very good. The meal should be poured gradually into boiling water and stirred until it is free from lumps and just thick enough to be cut with a knife. The poultice must be smoothly spread upon a piece of muslin and covered with some thin material.

Bread poultices are made by pouring boiling water over soft bread, until it is soft enough to be spread smoothly. These poultices are lighter than those made of linseed, but they cool more quickly.

Mustard poultices are made by adding mustard to the ordinary linseed poultice.

Other excellent poultices are made of starch, hops, bran, etc.

Baths.—Bathing is at all times a matter of great importance for the maintenance of health; but in sickness it becomes even more necessary, and cleanliness is a positive aid to recovery.

If care is exercised, no harm will occur, as a general rule, from the bathing. A feeble patient should be wrapped in a sheet and lowered gently into the water. A warm, dry sheet should be kept ready for use when the patient leaves the bath.

Baths are composed almost entirely of water, to which medicaments are sometimes applied. They are either *hot*, *tepid*, or *cold*.

The temperature of the bath-room should be carefully regulated, and the duration of the bath must be considered. Cold and hot baths should not usually be continued more than five minutes, and tepid baths not more than a quarter or half an hour.

Summary for Review.

1. *Why should a room be set aside for the sick whenever possible?*

   Because the surroundings, when good, tend to hasten the recovery of the patient.

2. *Where should this room be situated?*
   At the top and on the sunny side of the house.
3. *How should the room be furnished?*
   It should be plain, but at the same time cheerful and pretty.
4. *Why should whispering be forbidden in a sick-room?*
   Because it irritates and therefore injures the patient.
5. *What care should be taken in regard to the patient's bed clothes?*
   They should be frequently changed, but carefully kept away from all others in the house.
6. *What care must be taken in ventilation?*
   The room should be thoroughly ventilated, but in such a way as to prevent draughts.
7. *What precautions should be taken in regard to medicines?*
   The bottles should be carefully labeled and kept in a cool, dark, and dry place. Medicines should never be given in the dark.
8. *What kind of food should be given to the sick?*
   None but the best, and such as is easily digested.
9. *What are contagious diseases?*
   Those in which germs are thrown off which come in contact with others and cause in them the same disease.
10. *How may they be prevented?*
    By proper ventilation and by disinfection.
11. *Name some disinfectants.*
    Carbolic acid, sulphur, white vitriol, copperas, and chloride of lime.
12. *Name three useful styles of bandage.*
    The roller, the many-tailed, and the triangular bandage.

13. *What are poultices used for?*
    To prevent or check inflammation and to relieve pain.
14. *Name several useful kinds of poultices.*
    Linseed poultices, mustard poultices, and poultices made of starch, hops, or bran.
15. *When is bathing of the utmost importance?*
    In cases of sickness.
16. *How should a patient be protected while bathing?*
    By being wrapped in a warm, dry sheet before entering and immediately after leaving the bath.

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